DRAFT
DETAILED PROJECT REPORT
and
ENVIRONMENTAL STATEMENT

GARAPAN FLOOD CONTROL
Saipan, Northern Marianas

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation
Honolulu District

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858

PODED-PJ

28 July 1980

Pacific Region Manager
Office of Coastal Zone Management
3300 Whitehaven Street, N.W.
Washington, D.C. 20235

Dear Sir:

A Draft Detailed Project Report with Environmental Statement has been completed for the Garapan Flood Control Study, Saipan, Northern Marianas. Comments on this document are requested by 15 September 1980 so that they may receive full consideration in the final report.

Sincerely,

KISUK CHEUNG
Chief, Engineering Division

1 Incl
Report

ERRATA SHEET

GARAPAN FLOOD CONTROL STUDY
SAIPAN, CNMI

MAIN REPORT

1. Page 18, paragraph 2, line 8: "a million dollars" should read "ten million dollars".

ENVIRONMENTAL STATEMENT

1. Page 4, paragraph 3.2a.(2), line 4: Revised line should read "Mean sea level at its seaward end, sloping upward to -2.7 feet at its con-".

APPENDIX C, ENGINEERING INVESTIGATIONS, DESIGN AND COST ESTIMATES

1. Page C-5, Table C-3. Summary of First Costs: The culvert installation cost for Plan 1 should read $669,000, not $669,999.

DETAILED PROJECT REPORT
AND
ENVIRONMENTAL STATEMENT

A STUDY TO DETERMINE THE FEASIBILITY OF PROVIDING FLOOD CONTROL IMPROVEMENTS FOR GARAPAN, SAIPAN, COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

U.S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FORT SHAFTER, HONOLULU 96858

JULY 1980

GARAPAN FLOOD CONTROL

SAIPAN, CNMI

MAIN REPORT

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INTRODUCTION

STUDY AUTHORITY

By letter dated 9 May 1978, the Northern Marianas Commonwealth Legislature requested assistance for flood control improvements in the Garapan area. The purpose of this report is to evaluate the extent of the flood problem and to determine the feasibility and justification of Federal participation in providing flood mitigation measures in the Garapan area.

The study and report were accomplished under the authority of Section 205 of the 1948 Flood Control Act, as amended:

> "The Secretary of the Army is authorized to allot from any appropriations heretofore or hereafter made for flood control, not to exceed $30,000,000 for any one fiscal year, for the construction of small projects for flood control and related purposes not specifically authorized by Congress, which come within the provisions of Section 1 of the Flood Control Act of June 22, 1936, when in the opinion of the Chief of Engineers such work is advisable. The amount allotted for a project shall be sufficient to complete Federal participation, in the project. Not more than $2,000,000 shall be allotted under this section for a project at any single locality, except that not more than $3,000,000 shall be allotted under this section for a project at a single locality if such project protects an area which has been declared to be a major disaster area pursuant to the Disaster Relief Act of 1966 or the Disaster Relief Act of 1970 in the five-year period immediately preceding the date the Chief of Engineers deems such work advisable. The provisions of local cooperation specified in Section 3 of the Flood Control Act of June 22, 1936, as amended, shall apply. The work shall be complete in itself and not commit the United States to any additional improvement to insure its successful operation, except as may result from the normal procedure applying to projects authorized after submission of preliminary examination and survey reports."

Section 502 of the Covenant Act to establish the Commonwealth of the Northern Marianas (PL 94-241) provided that the U.S. Army Corps of Engineers' continuing authorities for small projects are also applicable to the islands of the Northern Marianas.

SCOPE OF THE STUDY

The Northern Mariana Islands are a chain of 16 islands in the Western Pacific approximately 3,800 miles west of Hawaii (Figure 1). Saipan, the capital and population center, is the largest island in the Northern Mariana Islands. The island is about 13 miles long, between 1-1/2 and 7 miles wide and has an area of 48 square miles (Figure 2).

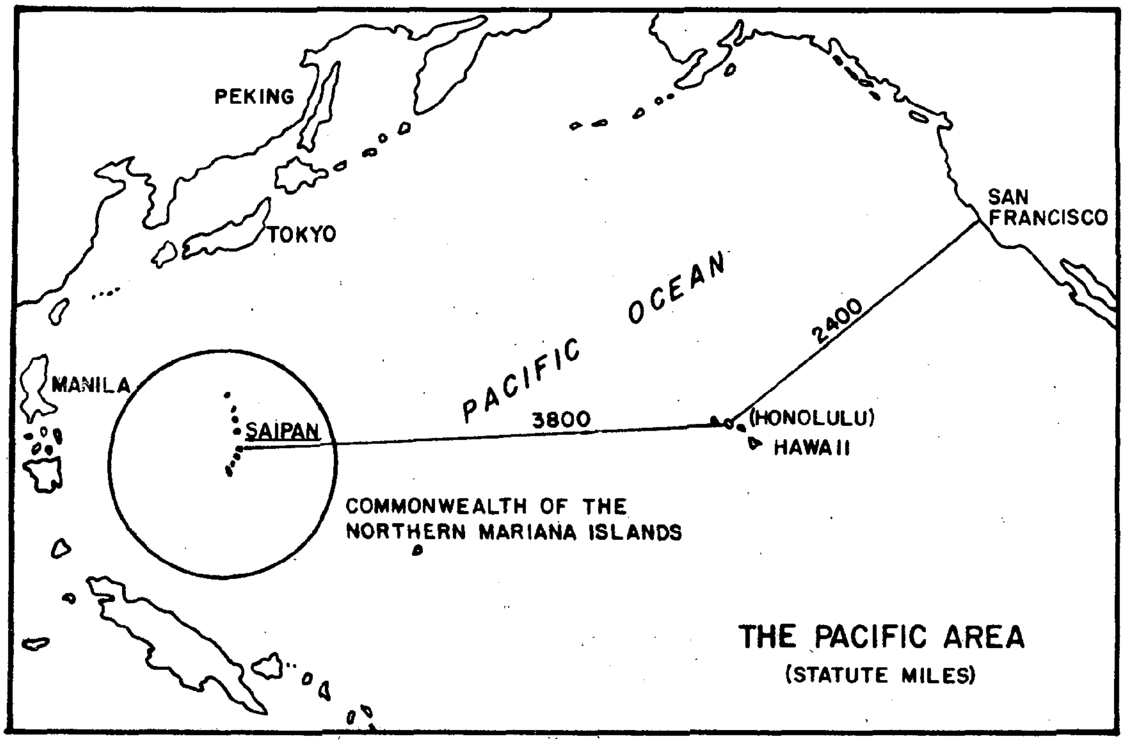


FIGURE I

The purpose of this draft document is to present the results of engineering and economic analyses which will serve as the basis for the selection of a feasible plan for alleviating the flood problem in Garapan. The study focused on an evaluation of this flood problem development of conceptual measures for protecting the flood-prone areas and preventing flood damages, and the costs, benefits and environmental impacts associated with implementing these measures.

STUDY PARTICIPANTS AND COORDINATION

The US Army Corps of Engineers, Honolulu Engineer District, was responsible for conducting the overall study and preparing the report. Studies and investigations were performed with the assistance of the Department of Public Works and the Mariana Islands Housing Authority (MIHA), both of the Government of the Northern Marianas. Initial coordination meetings and a public workshop were conducted in March 1979. These meetings focused on an identification of the flooding problem and solicitation of the needs and desires of the general public as well as local officials.

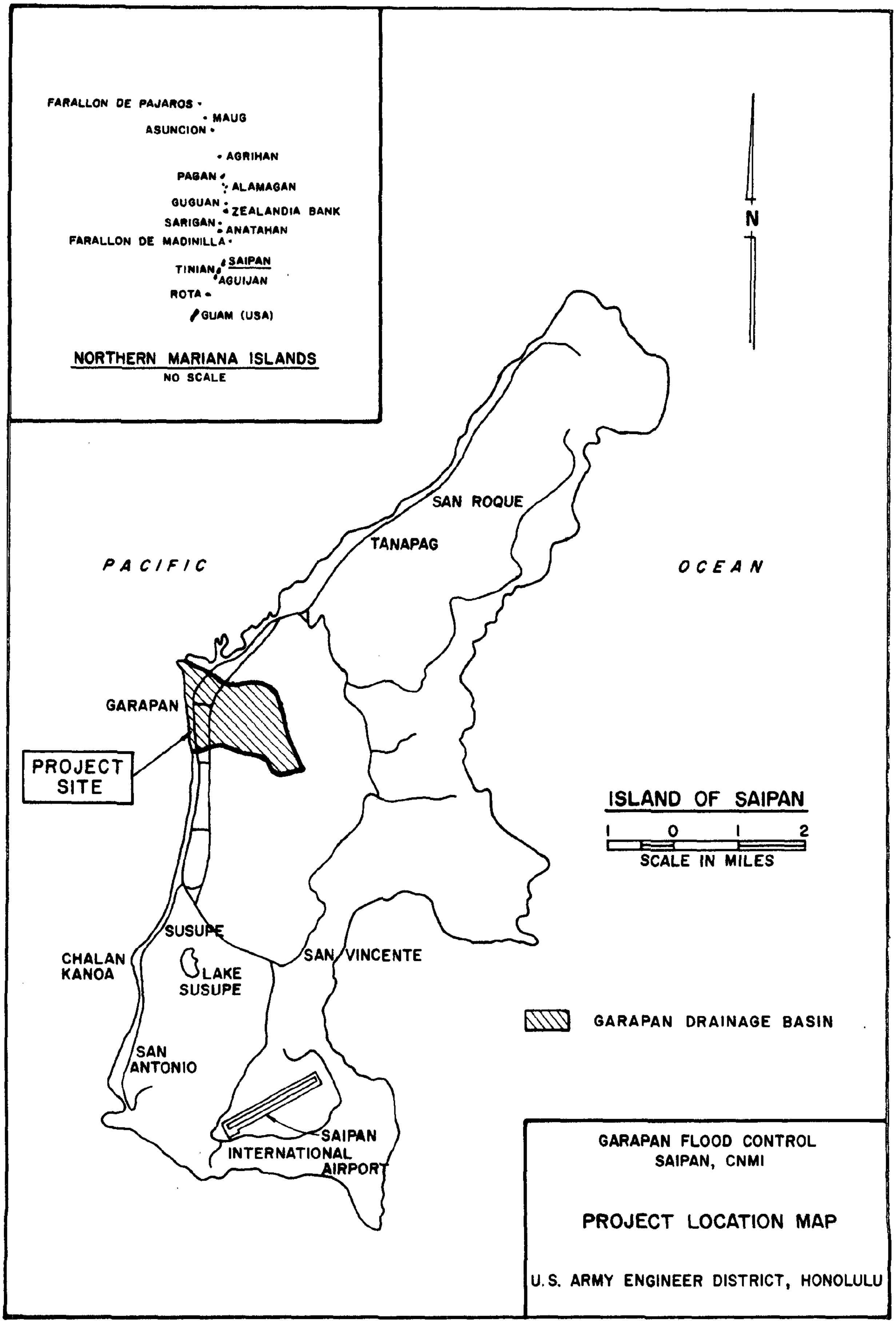

FARALLON DE PAJAROS
MAUG
ASUNCION
AGRIHAN
PAGAN
ALAMAGAN
GUGUAN
ZEALANDIA BANK
SARIGAN
ANATAHAN
FARALLON DE MADINILLA
SAIPAN
TINIAN
AGUIJAN
ROTA
GUAM (USA)
NORTHERN MARIANA ISLANDS
NO SCALE
N
SAN ROQUE
TANAPAG
PACIFIC
OCEAN
GARAPAN
PROJECT SITE
ISLAND OF SAIPAN
1 0 1 2
SCALE IN MILES
SUSUPE
CHALAN KANOA
LAKE SUSUPE
SAN VINCENTE
GARAPAN DRAINAGE BASIN
SAN ANTONIO
SAIPAN INTERNATIONAL AIRPORT
GARAPAN FLOOD CONTROL
SAIPAN, CNMI
PROJECT LOCATION MAP
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 2

PERTINENT STUDIES

A reconnaissance report, recommending that detailed studies be undertaken to determine the feasibility of providing flood control improvements for Garapan, was completed in November 1978 by the Corps of Engineers. As a result, this detailed study was authorized.

In order to prepare for Commonwealth Government, the Office of Transition Studies and Planning (OTSP) was created to assess social, cultural, governmental, and physical development needs of the Northern Mariana Islands, and to recommend directions and areas of effort which should be emphasized under the newly elected Commonwealth government. Three documents were prepared by the OTSP:

(1) The Socioeconomic Plan, finalized in October 1977, investigated the natural, human, and economic resources in the Northern Mariana Islands; and presented goals and strategies for economic growth.

(2) The Government Plan presented the necessary government structure and organization plan in preparation for Commonwealth government.

(3) The Physical Development Master Plan translated the policies, objectives, and funding targets developed in the Socioeconomic Development Plan into specific capital improvement programs with emphasis on the 1978-1985 period. The Plan also presented recommended zoning and building regulations and possible implementation procedures.

In May 1979, the Coastal Resources Management Office of the Commonwealth of the Northern Mariana Island completed a draft of the Coastal Land and Water Use Plan (CLWUP) of the Commonwealth. Its purpose was to present a comprehensive land and water use plan which would encompass previous planning efforts with an emphasis on wise conservation and use of the Northern Marianas' resources.

STUDY PROCESS

This study follows the guidelines of the Principles and Standards for Planning Water and Related Land Resources, prepared in 1973 by the US Water Resources Council and related Corps of Engineers regulations. The planning process involves plan selection based on increasingly detailed investigations by reiteration of the four interactive tasks of problem identification, formulation of alternatives, impact assessment, and evaluation. Under the Section 205 authority, the Detailed Project Report (DPR), serves as the feasibility, design, and construction authority document.

THE REPORT

This document consists of a main report which includes the environmental statement, and a series of supporting appendices. The main report is a self-contained document which describes the planning effort and includes the

Environmental Impact Statement. The appendices contain technical detail information and backup data to support the information presented in the main report:

The appendices are:

Appendices	Title
A	Hydrology
B	Geology and Soils
C	Engineering Investigations, Design and Cost Estimates
D	Economics
E	Social and Cultural Resources
F	Public Involvement
G	Recreation and Natural Resources
H	Compliance Documents

PROBLEM IDENTIFICATION

The purpose of problem identification is to develop planning objectives which will guide the formulation of alternative plans. Public concerns which relate to water and related land resource problems are identified and then refined based on national and local policies and the study authority. To identify the resource management problems, the base condition of the study area is defined. The base condition is the existing economic, social, and environmental chracteristics of the area. Future conditions are then projected and analyzed to determine the "most probable future" which would prevail over the area without any changes to the existing resource management plans. This analysis produces the without condition criterion. Planning objectives are then established based on the problems and needs of the area as related to the without condition criterion and national and local planning policies.

NATIONAL OBJECTIVES

The Principles and Standards (P&S) for planning water and land resources define the national objectives of National Economic Development and Environmental Quality. The national objectives provide the basis for formulation and analysis of alternative plans. The National Economic Development (NED) objective is achieved by increasing the value of the nation's output of goods and services and improving national efficiency. The Environmental Quality (EQ) objective provides for the management, conservation, preservation, or improvement of the quality of certain natural and cultural resources and ecological systems in the study area. P&S also require that the impacts of a proposed action be measured in terms of Regional Development (RD) and Social Well-Being (SWB). Contributions to the RD account are determined by establishing a proposal's effects on the region's income, employment, population, and economic base. Contributions to the SWB account are determined by establishing a proposal's effects on real income, security of life, health and safety, education, and emergency preparedness.

PROFILE OF BASE CONDITIONS

Physical Setting. The study area (Figure 2) is located on the west-central coast of Saipan. The 1.9 square mile rectangular-shaped basin is about 1-1/2 mile long and averages about 1-1/4 mile in width. Garapan Village is located on the western coastal plain. This relatively flat coastal plain varies from 1,000 to 3,000 feet in width and is composed essentially of limesand or artificial fill over limesand. Upland of the coastal belt are steep axial uplands, characterized by a succession of nearby flat benches and vertical scarps of limestone. Slopes in the uplands vary from about 30% to nearly vertical.

The climate of Saipan is tropical marine characterized by warm and humid conditions throughout the year. Wind and rainfall are the most variable elements with humidity, temperature, and barometric pressure remaining fairly constant. Average temperature in Saipan is 81.5°F (27.5°C) and humidity averages 83 percent.

During nineteen years of recorded data, annual rainfall extremes recorded at Garapan ranged from 59.8 inches to 115.1 inches. Annual rainfall over this same period averaged about 83 inches. Records indicated that the heaviest rainfall occurs from July through October.

Tradewinds are the dominant feature of the wind regime on Saipan. Tradewinds are pronounced from January through May, blowing from the northeast and east-northeast direction more than 90 percent of the time. Wind directions are far more variable during the remaining months. Average wind velocity throughout the year is 10.5 miles per hour.

Two principal kinds of storms contribute to the climatic character of Saipan: localized thunderstorms and squalls, and cyclonic tropical storms and typhoons. Saipan is located in a part of the western Pacific that is frequently crossed by tropical storms and typhoons. These low pressure systems are accompanied by high winds (sometimes in excess of 150 miles per hour) and heavy rains. Historically, the heaviest rains have occurred during tropical storms and typhoons. During Supertyphoon Pamela in 1976, 27 inches of rainfall were recorded in a 24-hour period in Guam, located about 120 miles south of Saipan. Although the recorded frequency of typhoons affecting Saipan is irregular, statistics show that one typhoon a year affects Saipan significantly.

Human Resources. The present population of Garapan represents about 11 percent of the total island population of 14,800. Today, Chamorros, Carolinians, and Micronesians comprise over 80 percent of the total island population. Alien labor, U.S. expatriates and tourists comprise the remainder of the population.

Since western discovery by Magellan in 1521, Saipan has come under various rules. Saipan was originally inhabited by Chamorros who mirgrated from southeast Asia in approximately 500 BC. Under Spanish rule (1521-1898), the Chamorros were forced to relocate to Guam but later resettled on Saipan during the 1800's. It was also during the 1800's that several hundred Carolinians established settlements in Saipan. Following the Spanish-American War in 1898, Germany obtained administration of the island. By World War I, Japan, which dominated trade in the region during the German rule, had obtained administration of Saipan. By 1930, the total population of Saipan was about 45,000 of which less than 10 percent were native (Chamorro and Carolinian). Under the Japanese administration, sugar production was developed on a large scale. Garapan became the center of population and commerce. Saipan was captured by the U.S. during World War II and in 1947 the United Nations granted trusteeship to the U.S. Until recently, the Northern Marianas were part of the Trust Territories of the Pacific Islands. On 9 January 1978, under the terms of the Covenant Act (Public Law 94-241), the President of the United States approved establishment of the Commonwealth of the Northern Mariana Islands.

Development and Economy. Approximately 50 percent of the total labor force on Saipan is employed by the Government. The most significant industries in the terms of employment and wage distribution are: personal services (tourism and tourism-related); wholesale and retail trade; and transportation and public utilities. Tourism is and will continue to be a significant economic base. In 1977, more than 58,000 tourists visited Saipan, with the bulk of them being Japanese. It is estimated that in 1976, $5.6 million was added to the economy through the visitor industry. Presently, there are six first class hotels on Saipan with approximately 780 rooms. Three of these hotels are located in the study area. The 30th Annual Report of the Trust Territory indicates that total exports for the Northern Marianas Islands in 1978 amounted to $4,398,000 which included $756,000 worth of goods; $3,600,000 in tourist goods; and $130,000 in marine products.

Existing land uses in the Garapan study area include residential development along both sides of Beach Road, an elementary school, and three of Saipan's largest hotels Figure 3. Just north of the study area is the American Memorial Park, which is a 133-acre area set aside for public use as a memorial to American and Marianas people who were killed or wounded in the Marianas Campaign during World War II. Also, located north of the study area are the island's only dock and port facilities and an industrial area.

Because of the various governmental administrations on Saipan over the years, land records are extremely complex. Land and land ownership play a major role in the culture and values of the people of the Northern Mariana Islands. Land ownership is closely tied with family solidarity and a sense of group responsibility. It is often considered solemn duty to retain land within the family, especially among those of Carolinian heritage. This reluctance to sell land has created a high market valuation of land. Figure 4 illustrates the generalized land tenure for the study area.

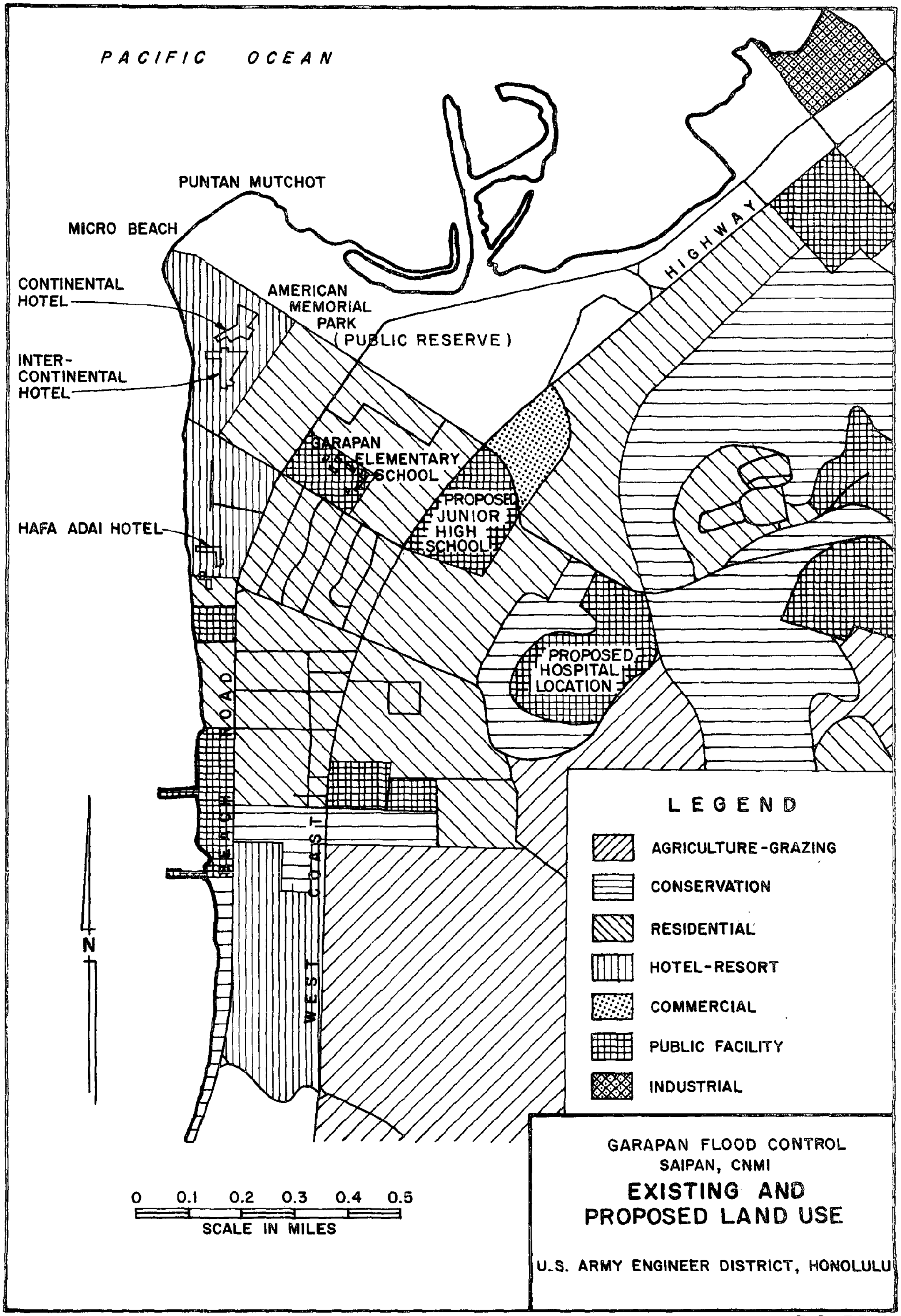
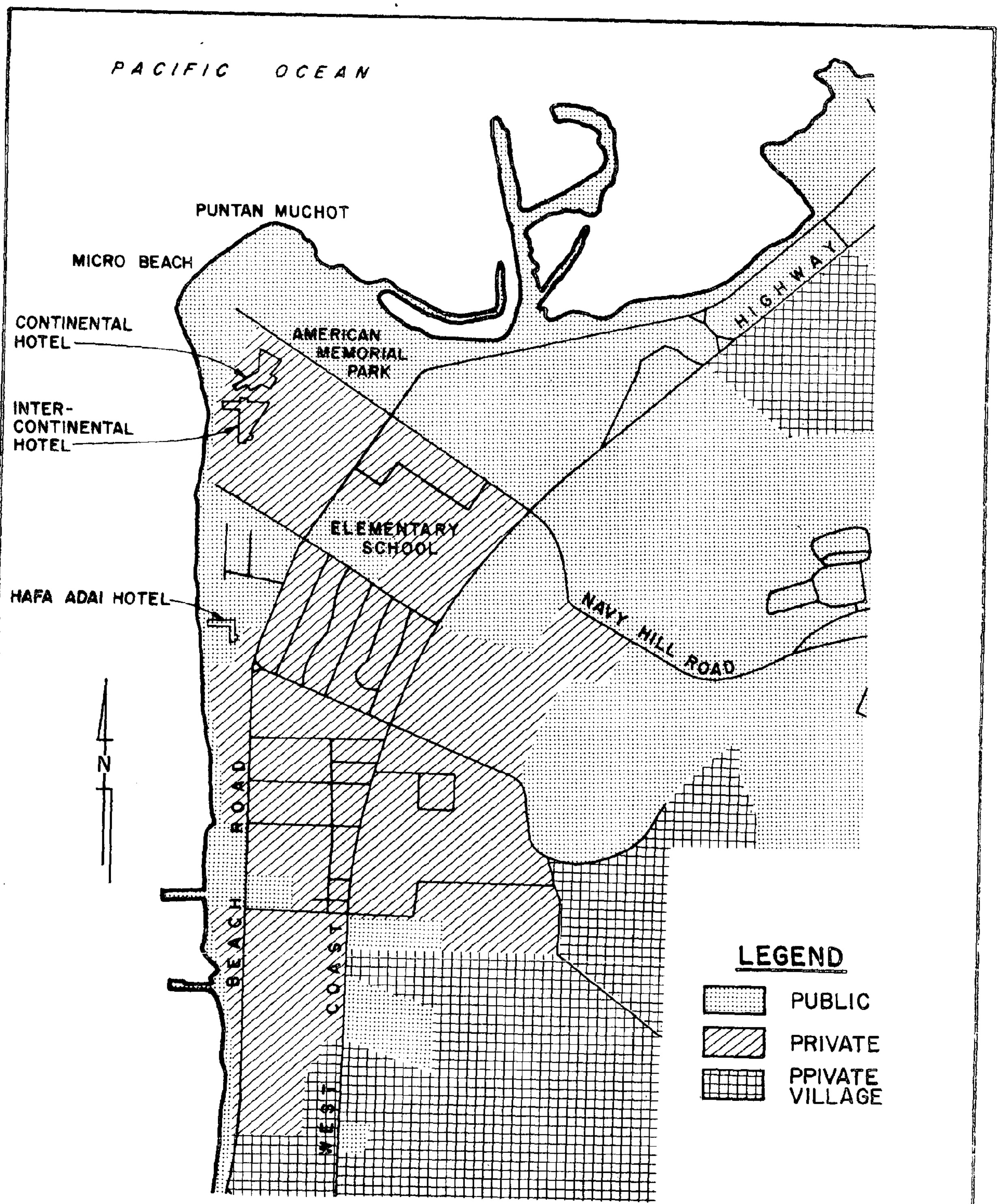

PACIFIC OCEAN
PUNTAN MUTCHOT
MICRO BEACH
CONTINENTAL HOTEL
INTER-CONTINENTAL HOTEL
AMERICAN MEMORIAL PARK (PUBLIC RESERVE)
HIGHWAY
GARAPAN ELEMENTARY SCHOOL
PROPOSED JUNIOR HIGH SCHOOL
HAFA ADAI HOTEL
PROPOSED HOSPITAL LOCATION
BEACH ROAD
WEST COAST
N
LEGEND
AGRICULTURE-GRAZING
CONSERVATION
RESIDENTIAL
HOTEL-RESORT
COMMERCIAL
PUBLIC FACILITY
INDUSTRIAL
0 0.1 0.2 0.3 0.4 0.5
SCALE IN MILES
GARAPAN FLOOD CONTROL
SAIPAN, CNMI
EXISTING AND PROPOSED LAND USE
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 3



SOURCE:
PHYSICAL DEVELOPMENT MASTER PLAN FOR THE COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS, JANUARY, 1978.

0 0.1 0.2 0.3 0.4 0.5
SCALE IN MILES

GARAPAN FLOOD CONTROL
SAIPAN, CNMI

LAND TENURE
(GENERALIZED)

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 4

CONDITIONS WITHOUT FEDERAL PROJECT

Land Use. The Physical Development Master Plan presents a proposed land use plan for the Garapan area (Figure 3). The proposed plan is based on the concept that Garapan will grow as an independent urban community. It should be recognized that Garapan is already experiencing the fastest residential growth in Saipan. Many factors contribute to Garapan being an ideal site for growth. These include the availability of easily developable land, the presence of water, sewer, and power service, and the probable development of a number of public facilities in the area.

The Master Plan presents a number of proposals for public facilities on the Garapan study area. These are:

(1) Construction of a junior high school at the intersection of Navy Hill Road and West Coast Highway.

(2) Construction of an acute care hospital on Navy Hill Road.

(3) Reconstruction of the Garapan Sugar Dock into a fishing village complex. In conjunction with the proposed fishing village, the Legislature of the Commonwealth of the Northern Mariana Island requested the US Army Corps of Engineers to study the feasibility of providing a small boat harbor in this area. Presently, the harbor study is scheduled for completion in late 1980 under the authority of Section 107 of the Rivers and Harbors Act of 1960, as amended.

(4) New residential construction. Garapan is undergoing rapid residential growth. The Garapan Estates, for low to moderate income families, is being constructed under the auspices of the Mariana Islands Housing Authority (MIHA). Site development for phase I of the Sugar King II subdivision is presently being conducted by MIHA. Ultimately, this development will add more than 200 new houses in the study area.

In addition, the Physical Development Master Plan suggests the possible expansion of tourist accommodations by the construction of another hotel in the coastal strip between the Hafa Adai Hotel and Saipan Intercontinental Hotel. A community commercial center, to be located just north of the junior high school site, is also proposed. Commercial activities will be limited to personal service uses, such as banks, grocery stores, insurance offices, laundromats, barber shops, bakeries, restaurants, and other similar uses. In conjunction with the commercial center, a multiple family residential area is proposed in the area surrounding the commercial center. Other proposals for the near vicinity but not within the study area are port and dock facilities improvements and upgrading of the industrial park, both located north of Garapan in Tanapag.

Economy. Tourism and agriculture are expected to play major roles in the development of the Commonwealth. Construction is also expected to increase significantly. A more limited role is projected for manufacturing and services and trade. Government is still expected to employ the majority of the work force even with the relocation of the Trust Territory Government headquarters to Ponape by 1981.

The visitor industry is expected to be the leading industry for development in the immediate future. By 1985, it is estimated that 200,000 persons will visit the northern Mariana Islands annually, which represents almost a four-fold increase over the present visitor count. With the expanding tourist industry, related services such as restaurants, tourist agencies, sports fishing, car rental, and souvenir shops should be enhanced.

Garapan, because of its beautiful beaches, will remain a popular tourist destination. Popular hotels, such as the Saipan Continental, the Saipan Intercontinental, and the Hafa Adai are located within the project area. Construction of another hotel should add to the economy, both in terms of construction and tourism.

PROBLEMS AND NEEDS

The Flood Problem. Although their history has not been documented, floods are a common occurrence in the lower Garapan area. Many long time residents have stated that flooding is experienced almost yearly. Because of the relatively flat terrain in the lower basin and the lack of a suitable outlet channel, severe ponding problems occur following moderate as well as heavy rainfall. Developments within the basin which are subject to flooding include an extensive number of residential structures, some small "mom and pop" stores, and moderate sized commercial establishments. Photographs of flooding in Garapan on file with MIHA were reviewed by members of the Honolulu District during a field investigation in February 1979. The photos included floods of August 1976, September 1977, and August 1978.

Although the Garapan area is frequently plagued by flooding problems, detailed records of past floods are not available except for the flood of August 1978 resulting from Tropical Storm Carmen, the worst flooding in Garapan in recent years recalled by local residents. Flooding from this storm caused an estimated $2.0 million dollars in damages to private dwellings, public facilities, and agricultural crops in Saipan. In the Garapan area, damage records revealed that total damages exceeded $200,000. Most of the damage were to newly-built private dwellings in the Annex I, Annex II, and Puntan Muchot subdivisions (Table 1 and Figure 5). The maximum flooded area was about 90 acres. Depths of inundation ranged up to 1-1/2 feet of essentially non-velocity flooding. The bulk of damages resulted when silt-laden stormwaters entered houses and damaged home contents. Furthermore, stormwaters remained ponded over a period of days within the housing areas, hindering cleanup efforts and daily activities. On 18 August 1978, President Carter, acting on a request from Governor Carlos Camacho, declared the Commonwealth of the Northern Marians a federal disaster area. The August 1978 flood is estimated to have a recurrence interval of 30 years.

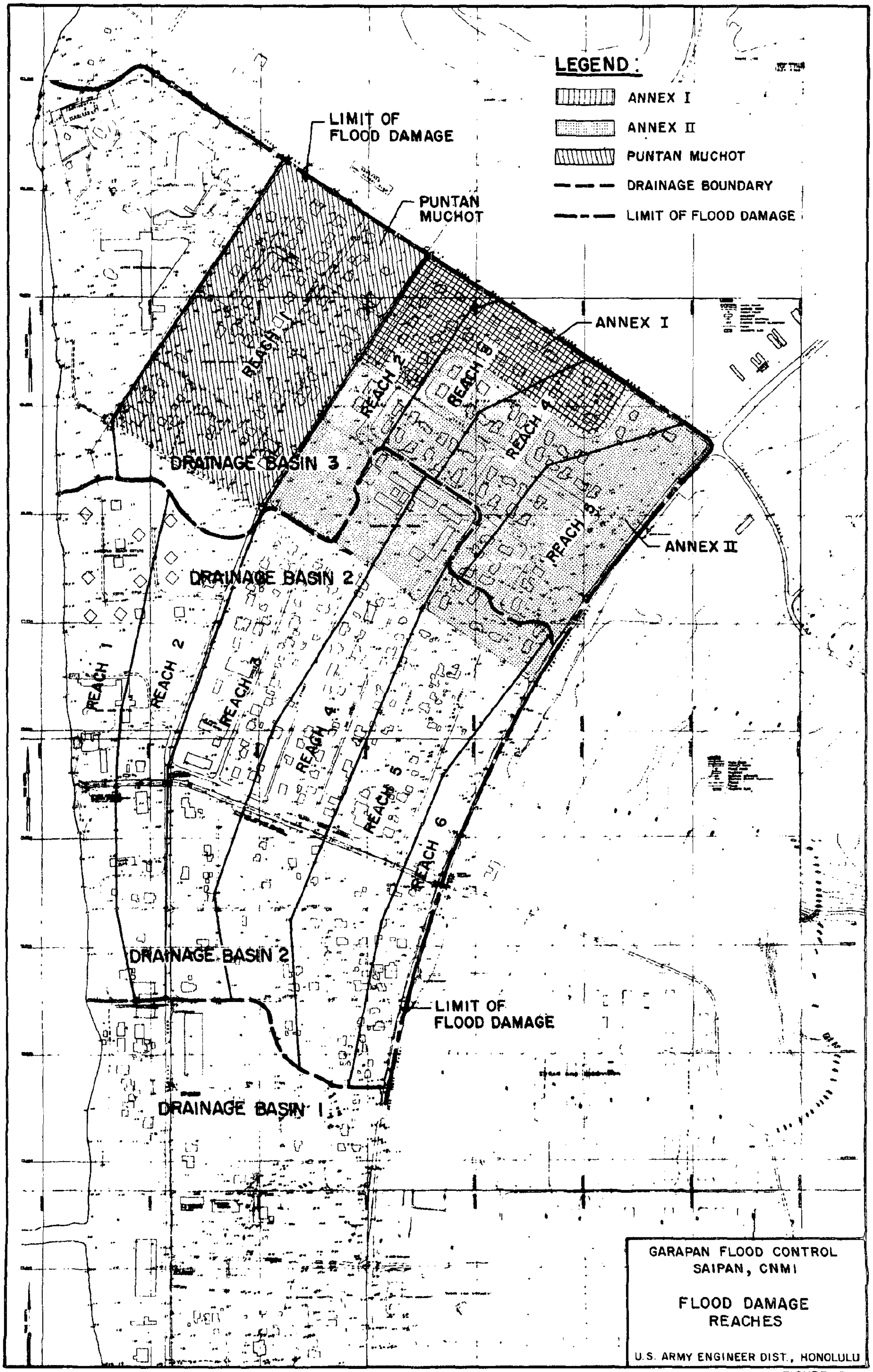

LEGEND:
ANNEX I
ANNEX II
PUNTAN MUCHOT
DRAINAGE BOUNDARY
LIMIT OF FLOOD DAMAGE
LIMIT OF FLOOD DAMAGE
PUNTAN MUCHOT
ANNEX I
ANNEX II
REACH
REACH 2
REACH 3
REACH 4
REACH 5
REACH 1
REACH 2
REACH 3
REACH 4
REACH 5
REACH 6
DRAINAGE BASIN 3
DRAINAGE BASIN 2
DRAINAGE BASIN 2
DRAINAGE BASIN 1
LIMIT OF FLOOD DAMAGE
GARAPAN FLOOD CONTROL
SAIPAN, CNMI
FLOOD DAMAGE
REACHES
U.S. ARMY ENGINEER DIST., HONOLULU
FIGURE 5

Table 1

SUMMARY OF DAMAGES
FOLLOWING TROPICAL STORM CARMEN, AUGUST 1978
(Damage in $1,000)

Subdivision	No. of Structures	Damages			
		Content	Structural	Miscellaneous	Total
Annex I	31	$ 51.50	$23.96	$ 6.12	$ 81.58
Annex II	19	4.13	13.81	.02	17.96
Puntan Muchot	35	96.94	21.30	4.86	123.10
	85	$152.57	$59.07	$11.0	$222.64

Analysis of the Flood Problem. Flooding in lower Garapan can be attributed to two primary factors. The first factor is the lack of a suitable outlet channel to effectively convey runoff to the ocean. Under Japanese rule prior to World War II, shallow open drainage channels conveyed runoff from the As Rapugan and As Felipe hills, through Garapan, to the ocean. However post-World War II residential and commercial developments obliterated most of the channels, causing storm runoff to flow overland as sheetflow. The second factor, which is the relatively flat topography in the area, compounds the flood problem. The elevation range of the lower Garapan area is approximately 3 to 8 feet above mean sea level. Consequently runoff which enters lower Garapan spreads over the coastal plain and remains ponded in lowlying areas. Furthermore, construction of the Saipan Continental and Saipan Intercontinental Hotels on fill added to the problem by preventing water from flowing to the ocean and keeping stormwaters confined within the subdivision area. The existing flood control measures consist of ponding basins which are grossly inadequate.

The most critical area is located between the hotel resort area (Continental and Intercontinental Hotels) and the West Coast Highway. The area is designated Area 3A on Plate A-1 of Appendix A. Area 3A is the site of the residential subdivision developed by MIHA. There is no natural drainageway in Garapan. The only remaining drainageway constructed by the Japanese occupational forces is an earth, grass-lined ditch which runs from the West Coast Highway to the ocean along the Island Power Road. It has an estimated capacity of 190 cubic feet per second (cfs), a 2-year recurrence interval. Due to the land slopes and the lack of drainageways, floodwaters flow essentially in a northwestern direction.

Discharges from Area 1 (see Plate A-1) would flow along the highway towards Area 2. However, because of the limited culvert and swale capacities, discharges greater than 25 cfs generally overflow across the highway and flow into Area 1A.

Discharges from Area 2 would concentrate at a culvert crossing at the West Coast Highway, where seven 24-inch diameter pipes are located. The crossing feeds water into the Japanese built ditch.

Discharges from Area 3 flow over the low point of West Coast Highway in that vicinity and into the problem Area of 3A. The drainage system in Area 3A consists of a ponding area west of the highway and an open concrete ditch below the Beach Road. According to MIHA, the pond has the capacity of containing localized runoff but not flows originating from the upstream area east of the highway. The concrete ditch outlet is normally blocked by sand at the shoreline.

Related Problems and Needs. Two related water resource problems have been identified in conjunction with this flood control study: offshore water quality and interior drainage. Saipan Lagoon is located on the western side of Saipan, enclosed by a barrier reef located approximately 800 to 1500 yards offshore. Within the lagoon, water depths range from a few inches to about 30 feet. Water clarity and water quality, for the most part, are excellent. Based upon recent public input, water quality of the lagoon and its effects on the beaches are of concern to the community. The Coastal Land and Water Use Plan also emphasizes the aesthetic and recreational value of Saipan Lagoon.

The second related problem is interior drainage. While a plan of improvement would convey most of the basin runoff through Garapan, resolution of interior drainage problems is primarily a local responsibility and is not within the scope of this study.

In May 1978, the Commonwealth Legislature requested the U.S. Army Corps of Engineers to investigate the feasibility of the federal government assistance in alleviating flooding in the lower Garapan area. At the March 1979 public workshop, local residents stated their concern over the severity and frequency of flooding that they had experienced in the past, and they expressed the need and desire to see an end to the flooding problem.

PLANNING OBJECTIVES

Based on the analysis of social, economic, and environmental aspects of the study area, and an identification of problems and needs, the following planning objectives have been developed to guide the formulation and evaluation of alternative plans of improvement for reducing flood damages in Garapan.

a. Contribute to the reduction in floodwater damages in Garapan during the 1985-2035 period of analysis.

b. Preserve (or minimize detrimental effects to) the natural resources of the area during the 1985 to 2035 period of analysis.

FORMULATION OF PRELIMINARY PLANS

INTRODUCTION

The formulation portion of the study involves the development and evaluation of management measures which best fulfill the previously defined planning objectives. The initial step in the formulation process is the identification of a study constraints and criteria. Then a full range of possible management measures is identified which address the problems and needs of the study area. The next step involves a preliminary screening of the measures based on an examination of the technical adequacy, economic efficiency, environmental management, and social acceptability of each solution. The remaining measures are developed further to determine and compare their beneficial and adverse contributions for the purpose of selecting a plan. This draft report is intended to be a plan formulation document, meaning that a number of different alternatives is analyzed and presented for review and comment by local and federal agencies as well as the general public.

PLANNING GUIDELINES AND CONSTRAINTS

Several criteria and constraints are identified which affect the plan formulation process of the study. These considerations are categorized and described in terms of institutional policies of the Corps, institutional policies of local government, existing and proposed improvements of other agencies, design criteria, and environmental guidelines.

Institutional Policies of the Corps. Various Corps of Engineers' regulations on flood control will affect the magnitude of design and the ultimate decision for local and federal participation in terms of costs and responsibilities. The Corps may participate in studies leading to construction of urban flood damage reduction measures. Interior drainage facilities, which consist of structures designed to collect and convey runoff from rainfall in urban areas, are the responsibility of the local government.

Flood damage reduction works must conform to regulations on cost sharing and responsibilities between federal and nonfederal interests. The federal government, under applicable statutes of the Corps of Engineers' authorities, will fund all work (up to the statutory requirement of the authority) except for acquisition of land, easements, and rights-of-way, relocations (including utilities and bridges), and associated administrative costs which will be funded by the nonfederal sponsoring agency. In addition to costs indicated above, the local sponsor must agree to certain items of local cooperation. These items will be spelled out and agreed to by the local sponsor in a letter of compliance prior to construction.

Institutional Policies of the Local Government. As mentioned previously, the Physical Development Master Plan presents a land-use plan for the Garapan area (Figure 3). Among the major developments proposed for Garapan are a junior high school, a hospital, and two residential subdivisions (Sugar King I and Sugar King II). Implementation of any of these proposals are ultimately contingent upon funding and priorities of both the Commonwealth and the federal goverment. At the time of this report only the Sugar King II subdivision is under construction. Thus, of the proposed improvements, only Sugar King II is assumed existing in the base condition. However, based on conversations with local government officials, the proposed improvements can be realistically assumed to be implemented in the near future.

The construction plans for the Sugar King II subdivision show that a 100-foot greenbelt has been provided between the West Coast Highway and the subdivision. Conversations with local government officials indicate that this 100-foot easement could be used for flood control purposes.

A preliminary draft of the Coastal Land and Water Use Plan (CLWUP) was prepared by the Coastal Resources Management Office of the CNMI government in May 1979. The document will serve as the basis of conservation and development policies within the context of the Physical Development and Socio-Economic Development Plans. In the CLWUP, various Areas of Particular Concern (APC's) are delineated. The APC's are defined as unique areas requiring special management considerations. In Garapan, a combined wetlands, flood zone, and mangrove APC is identified. The CLWUP proposes, in part, that attempts should be made to "assist in the relocation of persons in this area, both to reduce damages to the resource values and risk to people's lives, homes, and property in times of floods," and "nonstructural methods of reducing flood damages to property and buildings shall be given preference over structural measures." This study will investigate a number of nonstructural measures including relocation as possible flood control measures.

In addition, the CLWUP identifies some historical/archeological site APC's which consist of all identified historic and archeological site which should not be disturbed and should be protected from destruction. Within the Garapan area, historic sites located within the Sugar King Historic Park include the Japanese Jail, Sugar King Monument, German Steps, Shinto Shrine, and Japanese Hospital. In addition, the historic Japanese Lighthouse is located inland, to the east of American Memorial Park (Figure G-1).

Existing and Proposed Flood Control Improvements of Other Agencies. At the present time, there are no facilities to convey basin runoff effectively through Garapan. The only existing flood control measures consist of small ponding basins which were constructed by MIHA to handle runoff from the Annex I and Annex II subdivision. However, these ponding basins are small and overflow during moderately-sized storms.

The Physical Development Master Plan for Saipan discusses drainage problems and recommendations to solve these problems. Garapan is identified as one area having "acute, chronic drainage problems.." The Plan recommends that a solution to the problem could involve "intercepting and diverting upland storm flows away from existing and proposed residential, commercial and industrial areas and either ponding in conservation area or channeling to the sea or through a combination of both methods." The Plan further recommends that "a detailed drainage study be conducted and a facilities plan be prepared for the combined regions of Lower Base, Garapan and Puntan Muchot, including Puerto Rico, the coastal area between Lower Base and Garapan."

Design Criteria, Level of Protection. In considering the desired level of protection for both structural and nonstructural alternative plans, the following procedure was used in the determination of various appropriate levels of protection:

a. Formulate plans and determine the level of protection afforded by maximizing net economic benefits.

b. Formulate plans for higher or lower degrees of protection based on the planning objectives established for the study and other factors, such as desires of local interests, environmental or social considerations, or design considerations.

c. Consider the chance and risk of exceeding various floods and the consequences of exceeding those floods.

Based on preliminary benefit maximization studies, net benefits are maximized approximately at the 50-year level of protection. The 2 percent or 50-year flood corresponds to a 87 percent risk that it will be exceeded one or more times in a 100-year period. It was recognized that alternative structural and nonstructural plans need not afford the same level of protection; however, in view of the benefit maximization studies, the 50-year level is considered the minimum acceptable level. This implies there is still a fair risk of exceeding such a flood level; however, residual damages are not expected to be significant. Flood limits of the Garapan area are shown on Figure 6.

Environmental Considerations. There are a number of statutory and regulatory requirements of the federal government which must be complied with during the planning process. The required coordination is largely related to the evaluation and assessment of potential project implementation and impacts on the environmental resources of the area. These requirements are depicted in Table 1 of the environmental impact statement.

MANAGEMENT MEASURES

Possible management measures for flood mitigation in the Garapan area can be separated into two broad categories, nonstructural measures and structural measures. The effectiveness of these measures in alleviating the flood problem and their economic feasibility and compatibility with existing and desired socioeconomic and environmental conditions in Garapan are discussed in the following paragraphs. The alternative of "No Development" would result in continued damages from flooding and restriction of land use in the flood plain. This action would not be responsive to the study area's needs and was therefore eliminated as an alternative.

Nonstructural Measures. Nonstructural measures would not reduce or eliminate the occurrence of floods. They are intended to minimize loss of life and damages when floods occur through implementation of various programs. These include flood warning and evacuation, floodproofing, relocation, and regulation of future development in flood plain areas through zoning ordinances and building codes.

a. Flood Warning and Temporary Evacuation. Flood forecasting can be considered useful in two ways: the preparation of temporary protection to minimize damage from an impending flood and the evacuation of floodplains anticipated to be inundated. Reliable and timely forecasts of potential flooding and flood stages are necessary to provide adequate warning for effective implementation of this measure.

b. Floodproofing. This measure consists of adjustments to structures and building contents which are designed or adapted primarily to reduce flood damages. Floodproofing includes, but is not limited to: (a) raising existing buildings, (b) providing floodwalls to protect structures and content, (c) providing flood shields for all openings, and (d) providing waterproof coatings to reduce seepage.

c. Permanent Evacuation and Relocation. This measure for reducing potential damages in flood-prone areas is the physical removal of all damageable structures located in the floodplain and converting the land to a use that is compatible with the degree of flood risk.

d. Floodplain Regulation. Floodplain regulation and management programs are designed to control development of flood-prone areas to lessen the damaging effects of floods. Floodplain regulation relies on local government's adoption and use of legal tools to control the extent and type of development which would be permitted in these areas. The Federal Flood Insurance Program gives residents the opportunity to purchase flood insurance to cover losses from flooding. However, Saipan is not presently under the Flood Insurance Program but indications are that it will be in the near future.

Structural Measures. A variety of structural measures exists for managing resources, reducing flood damages, and minimizing or preventing the occurrence of floods. These measures which confine and channel harmful floodwaters include ponding basins, levee and channel improvements, and combinations of these measures. The various structural measures were examined with respect to the study area.

a. Ponding. The function of ponding basins is to store a portion of the floodflow in such a way as to reduce the flood flows in the areas to be protected. Ideally, ponding basins should have high permeability for effective infiltration.

b. Levees and Channel Improvements. The occurrences of floods and their damaging effects can be controlled by the construction of levee and channel improvements which are designed to contain floodflows. These types of improvement include realigning the channel to eliminate restrictive bends, enlarging the channel capacity, lining the channel to prevent bank erosion, and constructing structures to confine, divert, or control floodwaters in a designated floodway.

1. SUMMARY

1.1 Major Conclusions. Plan 1 is designated the NED plan because of the largest net economic benefits among the plans considered. Plan 4 is designated the least environmentally damaging because it does not affect the wetlands and historic sites in the Garapan area and preserves the floodplain. However, the plan causes the greatest amount of social disruption. All the structural plans have the potential of degrading water quality in the lagoon due to the discharge of stormwater runoff and the water in the outlet channels is expected to be lower in quality than the lagoon waters. The discharge of fill material to line the channels is specified through the application of the US Environmental Protection Agency Section 404(b)(1) guidelines. No endangered species or their critical habitat are likely to be jeopardized by any of the alternatives.

All channel plans involve the potential loss of an archaeological data and may require archaeological salvage to mitigate the loss. Similarly all channel plans may involve work and alteration of wetland areas and will require mitigative measures to avoid the wetlands or to protect the wetlands from physical alteration.

1.2 Areas of Controversy. None known.

1.3 Unresolved Issues. None.

1.4 Relationship to Environmental Requirements. See Table 1.

2. NEED FOR AND OBJECTIVES OF THE ACTION.

2.1 Study Authority. The Garapan Flood Control Study was conducted under the authority of Section 205 of the Flood Control Act of 1948, as amended. The Flood Control Act authorized federal assistance in providing flood protection to a limit of $2,000,000, but $3,000,000 if the area has been declared a major disaster area.

2.2 Public Concerns.

a. The study was requested by the Legislature of the Commonwealth of the Northern Mariana Islands. The request indicated a desire to alleviate flooding problems in the Garapan village area of Saipan. Investigations were performed with the assistance of the Commonwealth Department of Public Works and Mariana Islands Housing Authority.

b. Flood occurrences are common in the coastal areas of Garapan. Factors contributing to the flood problems experienced in Garapan include extensive urban development in a flood prone area, lack of gradient which prevents adequate drainage, and the lack of drainage outlets. While records of past flood damages on Saipan are lacking, tropical storm Carmen, August 1978, caused an estimated $2,000,000 in damages on Saipan to residences, public facilities and crops. In the Garapan area the total damage was about $200,000, involving 85 newly constructed private dwellings in the Annex I,

TABLE 1

RELATIONSHIP OF PLANS TO ENVIRONMENTAL REQUIREMENTS

	Plan 1	Plan 2	Plan 3	Plan 4
National Environmental Policy Act of 1969	All plans are in full compliance.			
National Historic Preservation Act of 1966	Partial compliance. Historic Preservation Officer coordination required.			
Scenic and Wild River Act of 1968	Not Applicable			
National Trails System Act	Not Applicable			
Federal Water Project Recreation Act of 1965	All plans are in full compliance.			
Water Resources Development Act of 1974	All plans are in full compliance.			
Coastal Zone Management Act of 1972	In partial compliance. The Commonwealth has no approved CZM plan.			
Resource Conservation and Recovery Act of 1976	Not Applicable			
President's Water Policy Initiatives				
Water Conservation	Not Applicable			
Groundwater Supply and Instream Flows	All plans are in full compliance.			
E.O. 11988 Flood Plain Management	All plans are in full compliance.			Plan 4 preserves the floodplain.
Clean Water Act of 1977	Water quality certification required. Partial compliance.			Not Applicable
Noise Control Act of 1972	All plans are in in full compliance.			
Clean Air Act of 1976	All plans are in full compliance.			
Pesticide Control Act of 1972	Not Applicable			
Fish and Wildlife Coordination Act of 1959	Partial compliance. Fish and Wildlife report needed.			
Endangered Species Act of 1973, as amended	All plans are in full compliance.			
Marine Mammal Protection Act of 1972	Not Applicable			
Migratory Bird Treaty Act	All plans are in full compliance.			
Estuaries Protection Act of 1972	Not Applicable			
Marine Protection, Research and Sanctuaries Act of 1972	Not Applicable			
E.O. 11990 Protection of Wetlands	Partial compliance. Plans may affect wetland, but limits of wetland not accurately defined.			In full compliance.
E.O. 11987 Exotic Organisms	Not Applicable			

Annex II and Puntan Muchot subdivisions of Garapan (See Figure 5 of Main Report). On 18 August 1978, President Carter declared the Commonwealth area a disaster area as a result of the storm. At a public workshop held on Saipan in March 1979, local residents indicated their concern over the severity and frequency of flooding and expressd a desire to see an end to their flooding problems.

2.3 Planning Objectives. The following planning objectives were employed in plan formulation.

a. Contribute to the reduction of floodwater damage during the 1985-2035 period of analysis.

b. Preserve (or minimize detrimental effects to) the natural resources of the area during the 1985-2035 period of analysis.

3. ALTERNATIVES INCLUDING THE PROPOSED ACTION.

3.1 Plans Eliminated from Further Study.

a. Non-Structural Alternatives. Non-structural alternatives involved those alternatives which would reduce flood damages and losses without major construction. These alternatives included floodproofing, floodplain management and flood insurance.

(1) Floodproofing. Most of the homes in the floodprone areas are built on concrete slabs laid on the ground making it expensive to raise the homes above the flood elevations. Constructing berms or floodwalls around each home is not practical and is unacceptable to individual land owners. Other floodproofing measures include flood shields and waterproof coating.

(2) Floodplain Management. Floodplain ordinances have not been developed by the local government. If a program was developed it would apply to the future home construction and does not alleviate flood hazards for existing homes in the floodprone area. The local government is attempting to provide interior drainage to alleviate flooding, but it is not using any specific design criteria in the construction of the drainage structures. However, the local government is aware of the flood hazards and is attempting to alleviate flood damage potential in new developments requiring interior drainage as part of any housing development. Under US Department of Housing and Urban Development funding, interior drainage for a subdivision is required, but the drainage design does not require consideration of upland flows which enter the subdivision.

(3) National Flood Insurance Program. The CNMI does not participate in the National Flood Insurance Program. The program enables property owners to buy flood insurance for their homes and its contents at reasonable cost. However, the local government must develop floodplain management measures to protect lives and to regulate new construction in the 100-year floodplain in order to remain in the program. Flood boundary hazard maps have not been developed for Saipan and no floodplain management program is in effect. While the insurance offsets flood losses, damages and losses will continue to occur without structural measures to reduce the flood hazard.

(4) Interior Drainage. The local government is improving interior drainage in areas frequently damaged by floods associated with rainstorms of short intensity. These measures are required in conjunction with grants from the US Department of Housing and Urban Development, and will not accommodate floodwaters associated with rainstorms of long duration.

b. No Action. Flooding and flood damages will continue to occur if nothing is done by any one agency. Residents may be forced to design new homes or redesign existing homes so that they can be raised above anticipated flood elevations. Since most existing homes are constructed on concrete slabs, the homeowner will be forced to undertake major and expensive structural modifications to raise his house, or tolerate periodic flooding and property loss and damage.

3.2 Plans Considered in Detail.

a. Channelizing (Plans 1 to 3). The design concept involves a diversion channel above the West Coast Highway that will divert water from the upland portions of the drainage basin and into an outlet channel which will convey the waters through the flat coastal area into Saipan Lagoon. The diversion channel location and alignment remains the same for three alternative outlet channel alignments but the outlet channel location will vary. The diversion channel alignment follows the West Coast Highway for approximately 3,500 feet (See Figures 7 to 9), along a 100-foot rights-of-way. The channel invert will be 10-20 feet wide, and 7-11 feet below existing ground level. The channel will have a trapezoidal cross-section and will be lined with grass. Where flow velocities are erosive, riprap lining will be provided. The diversion channel may pass close to a wetland and an archaeological site. The exact location of both resources is not known, but methods to avoid the resources and to mitigate their losses will have to be considered if the channel does affect the resources. Aligning the channel to avoid the wetland and historic site will infringe on lands planned for junior high school use.

(1) Plan 1. For this alternative, the outlet channel empties into Saipan Lagoon about 300 feet south of Hafa Adai Hotel and follows an existing 21-foot-wide drainage channel. The channel will be riprap lined with a 35-foot base width and will have a trapezoidal cross-section. The channel depth will be -6.0 feet below MSL at its mouth, sloping upward to +0.2 feet MSL at the West Coast Highway connection with the diversion channel. The channel will be about 1,700 feet long and will be tidal for the majority of its length. A 120-foot rights-of-way passes through private and government property. The outlet channel would divide the diversion channel into a north and south branch. The south branch will have to be lined with rock. The alignment involves obtaining 5.0 acres of private land and the possible displacement or relocation of four homes.

(2) Plan 2. For this alternative, the outlet channel alignment passes around a wetland in the proposed American Memorial Park and discharges into Tanapag Harbor. The channel will be 1,800 feet long and will be 8 feet below mean sea level at its seaward and sloping upward to -2.7 feet at its connection with the diversion channel. The channel will be tidal for its entire

length. The channel will have a base width of 30 feet, will have a trapezoidal cross-section, and will be lined with riprap. A 110-foot rights-of-way through the park will be required. With this alternative the diversion channel will be grass-lined.

(3) Plan 3. For this alternative, the outlet channel alignment passes next to Garapan Elementary School and empties into Saipan Lagoon about 1,000 feet north of the Hafa Adai Hotel, adjacent to the Intercontinental Hotel property. Embankments will be kept low to prevent ponding of water in the floodprone areas. In order to contain floodwaters, the channel width will be wider than the other alternatives being considered. The channel base width will be 40 feet and will have a trapezoidal cross-section. The channel will be 2,500 feet long and lined with riprap. The channel depth will be 8 feet below MSL at its mouth and slope upward to 2-3 feet below the existing ground level at its connection with the diversion channel. The south branch of the diversion channel will be lined with riprap to protect the channel against streamflow erosion. The outlet channel alignment passes through 4.8 acres of private land and may possibly force relocation of four homes.

b. Plan 4, Relocation. Relocation involves removing damageable contents from floodprone structures and resettling contents and occupants in a flood-free location. Approximately 340 structures would need to be relocated to a flood-free area involving an estimated cost of more than $10 million. This alternative would significantly disrupt the community by relocating families and upsetting traditional values. Those persons who place a high value on land ownership, because of its association with family solidarity and a sense of family responsibility and participation, will be reluctant to leave traditional family owned lands. Those who view land as an economic commodity to be bought or sold for monetary gain will ask a high price for their landholdings. Since there is a lack of housing on Saipan, the local government may have to construct additional housing units to resettle dislocated families or individuals. The alternative also involves terrestrial habitat modification of unknown size and extent and unknown effects on cultural properties. The alternative avoids wetland alterations and possible degradation of coastal water quality due to point source stormwater discharges associated with channel construction.

3.3 Comparison of Alternative Impacts (see Table 2).

4. AFFECTED ENVIRONMENT.

4.1 Environmental Conditions. Garapan village lies in the central coastal area of western Saipan (See Figure 2, Main Report). The present population of the village is 1,700 persons representing about 11% of the total population on Saipan. However, the Garapan region also includes Saipan's only deepwater port facility and concentration of industry at Tanapag and the villages of Tanapag, San Roque, Capital Hill, and Navy Hill. The population of these areas including Garapan village represents about 40% of the total population on Saipan. The village of Garapan is located in an area adjacent to Puntan Muchot Peninsula, and is presently undergoing population growth more rapid than any other village on Saipan. Garapan estates and two Sugar King subdivisions are expected to double population in the Garapan area. Two of

COMPARISON OF ALTERNATIVE IMPACTS

	Diversion Channel*	Outlet Channel Plan 1	Outlet Channel Plan 2	Outlet Channel Plan 3	Relocation Plan 4
Length of Channel (feet)	3500	1700	1800	2500	N/A
Base width of channel (feet)	10-20 feet	35	30	40	N/A
Channel depth at mouth (feet)	None	-6msl	-8msl	-8msl	N/A
Channel shape	Trapezoid	Trapezoid	Trapezoid	Trapezoid	N/A
Channel lining	Grass. South branch riprap with Plans 1 & 3.	Riprap	Riprap	Riprap	N/A
Rights-of-way width	100 feet	120 feet	110 feet	130 feet	N/A
Flood protection provided	50 year	50 yr	50 yr	50 yr	N/A
Local flooding	Not Applicable	Reduced	Reduced	Reduced	Eliminated
Wetland destruction	Yes	No	Possible	No	No
Terrestrial Habitat Lost	0	1.9 ac.	2 ac.	3.4 ac.	Unknown
Terrestrial Habitat Modified	8 ac	0	0	0	Unknown
Lagoon Habitat Excavated	N/A	300 ft^2	400 ft^2	480 ft^2	None
Volume of Material Removed	N/A	1030 CY	1330 CY	1630 CY	N/A
Intertidal Habitat Created	0	0.19 ac	0.20 ac	0.28 ac	N/A
Total Water Volume in Channel	N/A	20940 CY	31600 CY	35040 CY	None
Tidal Prism	N/A	17000 CY	25930 CY	28570 CY	N/A
Migratory bird habitat	Increased	Increased	Increased	Increased	No Effect
Channelized storm water discharge	Yes	Yes	Yes	Yes	No
Littoral drift interruption	None	Probable	Not Probable	Probable	No

* Diversion channel is same for all 3 structural plans.

TABLE 2

COMPARISON OF ALTERNATIVE IMPACTS (Contd)

	Diversion Channel*	Outlet Channel			Relocation
		Plan 1	Plan 2	Plan 3	Plan 4
Threatened/Endangered Species	No	No	Probable	No	Unknown
Recreation	No effect	Increase recreational fishing. Interrupt pedestrian movement along the shoreline.			No Effect
Historic resources	Potential for destroying an archaeological site.	None	Channel passes through the American Memorial Park, has potential for unearthing WWII artifacts.	None	Unknown
No. of structures relocated	0	4	0	4	340
Private Lands Taken	0	5.0 ac	None	4.8 ac	--

* Diversion channel is same for all 3 structural plans.

Saipan's most modern hotels and Saipan's best beaches are located at Garapan. The Physical Development Master Plan for Saipan assumes that Garapan will remain a desirable location for new residential growth because of the availability of easily developable land. The plan also provides for a resort-tourist related industry, memorial park, historical park, port and industrial facilities, a new junior high school and elementary school, and a new hospital in the Garapan area. Figure 3 illustrates future land uses in the Garapan area.

4.2 Garapan may have been either a Chamorro or Spanish village prior to the removal of the native Chamorro population by Spain in 1660. Carolinians resettled Saipan in the 1800's and reestablished Garapan before the Chamorros returned to Saipan. During the Japanese occupation of Saipan, Garapan became the center of government, economy and population on Saipan, and the Japanese population far outnumbered the native population. During World War II, portions of Garapan were destroyed and later rebuilt as a fighter strip and as a naval port supporting US military operations. The native population was relocated to Chalan Kanoa/Susupe, but were later allowed to reestablish other villages including Garapan.

4.3 The Garapan coastal area consists of filled land and beach material. Alluvial material overlies hardened limestone at the foot of the limestone hills. Vegetation in the Garapan area reflects previous disturbance by man and is basically identified as coastal strand vegetation, urban vegetation (consisting of a mixture of strand, cultivated and upland vegetation), and the tangan tangan vegetation (cultivated during the war to control erosion). The upland hill areas consist of a mixture of tangan tangan and limestone forest vegetation. Wildlife in the area is dominated by introduced birds. No national shoreline or beach parks, wildlife sanctuaries or refuges, municipal water supply, harvestable shellfish beds, or prime agricultural lands are designated in the Garapan project area.

SIGNIFICANT ENVIRONMENTAL RESOURCES.

4.4 Floodplain. The Garapan drainage area is about 1.9 square miles with steep gradients in the hills and a relatively flat coastal plain. Flood problems in the coastal area where the majority of residences are located are caused by severe ponding in the relatively flat coastal area. The lack of a suitable outlet channel contributes to the problem. During the Japanese occupation of Saipan, shallow open channels conveyed runoff through the Garapan area into the ocean. Post World War II construction obliterated the channels causing storm runoff to flow overland as a sheet flow in the low-lying areas. Construction of the Saipan Continental and Intercontinental Hotels on fill raised the ground elevation along the shoreline inhibiting water flow to the ocean, forcing floodwaters into the low-lying subdivision. Essentially, damageable properties are located in a depression between the hills and the fill areas along the shoreline. The construction of roads above the elevation of the ground in the low-lying area aggravates flooding because the roads cause waters to pond.

4.5 Groundwater. No municipal groundwater supply sources are located in the area, and the close proximity to the ocean suggests that the water is not potable. Sewerage systems in South Garapan consist of cesspools and septic tanks. The leaching of wastewaters into the groundwater probably occurs. It is not known whether nitrogen laden waters are leaching into the lagoon along the shoreline. In Hawaii the leaching of wastewaters from cesspools into coastal waters along sandy areas has been identified as a water pollution problem. Coastal water quality data is insufficient to determine whether cesspools and septic tanks in the South Garapan area have any effect on coastal water quality. When floods occur, cesspools and septic tanks overflow, creating a health hazard in the community.

4.6 Littoral Processes. No information on littoral processes is available for the Garapan area. Aerial photographs and information concerning dredged areas at Garapan indicate that a predominant littoral drift is not present on the shoreline. The Garapan Dock area dredged during World War II still has a 12-foot depth despite the lack of any maintenance dredging. Old pier structures perpendicular to the shoreline do not appear to interrupt any along shore sand movement. Another dredged channel north of the Garapan Dock is still evident in aerial photographs. The aerial photographs also indicate that a strong current flow may exist in mid-lagoon where sand movement may be more prominent in the mid-lagoon area. Current surveys indicate that water in the lagoon flows seaward over the barrier reef at Garapan. A sand berm presently blocks the existing drainage channel suggesting that there may be an onshore/offshore movement of sand related to significant storm events.

4.7 Water Quality. No data are available for the Garapan area. No significant pollution sources are present along the shoreline, except for a boat launching ramp at Garapan Dock and an intermittent drainage ditch which discharges into Saipan Lagoon near the Hafa Adai Hotel. Water quality measurements were made in the Unai Sadog Tase area by the University of Guam. Salinity values ranged from 24.4 to 35.5 parts per thousand. Water temperatures ranged from 26.8 to 27.5°C. Dissolved oxygen levels ranged from 7.02 to 8.73 milligrams per liter indicating 109 to 136% oxygen staturation. Nitrate values ranged from 0 to 0.20 microgram-atoms nitrate per liter, and phosphate values ranged from 0.06 to 0.16 microgram-atoms phosphate per liter. The measurements indicate that water quality is relatively good with low concentration of nutrients, high levels of dissolved oxygen and water salinity reflecting some freshwater input. No wastewater discharges are located at Unai Sadog Tase, although the Puerto Rico dump is located just north of the area.

4.8 Wetlands. Two or three wetlands are located in the Garapan area (see Appendix G). The larger wetland is located in the proposed American Memorial Park area and two smaller wetlands are located in a residential area in Garapan Village. Grasses dominate the wetland areas, and the wetlands were previously disturbed and modified during World War II. The wetland in the proposed park area was once part of an airfield and is crossed by an eroded, overgrown asphalt road. The area was being used as a dump by the local population. The smaller wetlands are bordered by roads, some of which pass through the wetland. The wetlands provide habitat for a variety of upland birds and migratory shorebirds (see Appendix G). Seventeen species of birds were found in the wetland areas. Six species were found in the small wetlands and 12 species were found in the large wetland. The Chinese least bittern was common to both wetlands. In general, birds found in one wetland were not found in the other. The most abundant birds in the small wetland were the Chinese least bittern and ruddy turnstone. Birds common to the larger wetland were the Philippine Turtle Dove, Marianas Gallinule, White Tern, Cardinal Honeyeater and the Bridled White-Eye. A conceptual plan for the proposed American Memorial Park shows the wetland in the park developed as a Nature Study area and pond. The smaller wetlands are located in an area to be urbanized. The Unai Sadog Tase shoreline of the American Memorial Park is overgrown with mangroves forming a wetland area. No information about this wetland area is available.

4.9 Migratory Shorebirds. The US Fish and Wildlife Service (see Appendix G) observed the White Tern, Lesser Golden Plover, Whimbrel and Wandering Tattler in the urban and beach area of Garapan. The Cardinal Honeyeater, Eurasian Tree Sparrow, Philippine Turtle Dove and the Bridled White-Eye were the most abundant birds observed in the same area. If Garapan is developed in accordance to the Physical Master Development Master Plan, the presence of the migratory shorebirds may possibly decrease. However, the open beach and park space will also serve as resting and feeding areas for the migratory shorebirds. No nesting sites were found by the US Fish and Wildlife Service.

4.10 Lagoon Resources. A survey of fishery resources in Saipan Lagoon identified 24 fishery habitats and 249 species of fish, recommended preservation of 21 fishery habitats, and identified roughly 24 species of fish of economic importance. The habitats along the Garapan shoreline and Memorial Park shoreline were not identified as the habitats with the most significant fish diversity. The richest fish habitats were those associated with the barrier reef, reefs around Managaha Island and the Acropora thicket in Garapan channel. However, both the Garapan shoreline and American Memorial Park shoreline habitats were recommended for preservation and conservation based on the densities of economically valuable fish. The habitat along the Garapan shoreline fronting Hafa Adai Hotel, Garapan Dock and Mico Beach was described as a Enhalus acoroides seagrass habitat having a fine sand substrate and mixed with other seagrasses and algae. Rabbitfish were abundant in the habitat, while goatfish and snappers were relatively abundant. The mid-lagoon habitat further offshore consisted of sand and rubble dominated by algae with few economically important fishes.

The boat harbor within the Memorial Park is a dredged habitat consisting of a silty rubble substrate littered with wreckage that provides unique marine habitats by providing shelter and hard substrate above the bottom. While the highest counts of silversides were made in the habitat, the abundance of silversides was judged by the investigators to be low. Schools of juvenile jacks were also seen in the dredged channels. The habitats were not identified as important fish egg and larvae areas.

4.11 Endangered Species. The US Fish and Wildlife Service Endangered Species Office indicated that the threatened Green Sea Turtle and endangered Nightingale Reed Warbler have been seen in the project area. The status of 10 rare bird species and 2 mammalian species (bats) on Guam is being reviewed for possible inclusion on the Endangered Threatened Species list. The official status of the species on Guam does not necessarily correspond to the status of the species in the Commonwealth. The Guam list did include the Cardinal Honeyeater, Marianas Gallinule, White-throated Ground Dove, and the Bridled White-Eye, which were seen on Saipan. The Nightingale Reed-Warbler, which is endangered in the Trust Territory and Mariana Islands was also seen in the American Memorial Park wetland.

4.12 Recreation. The beaches along the lagoon shoreline provide water-contact recreation opportunities. Boating facilities are located at the Garapan dock and in the proposed American Memorial Park. Micro beach park, the beach fronting the Intercontinental and Continental and the Hafa Adai Hotels, and the Beach Drive beach park also provide recreational resources. Fishing occurs all along the shoreline and underwater tour operators utilize the lagoon for recreational diving and snorkeling. Surfing is not known to be a significant recreational diversion. Physical Development Master Plan for Saipan proposes the development of a Sugar King Historic Park and the development of the American Memorial Park. School grounds in the Garapan Village also serve recreational needs. A new junior high school is planned on the upland side of the intersection of the Navy Hill road and the Coastal Highway.

4.13 Historical Resources. The American Memorial Park land was set aside in 1978 for development as a park honoring those American and Commonwealth citizens who died during World War II. The proposed Sugar King Historic Park includes structures constructed during the German and Japanese occupation of Saipan. A lighthouse on Navy Hill and a lighthouse on the barrier reef offshore from Garapan dock were also constructed by the Japanese and are considered eligible for inclusion to the National Register of Historic Places. A cultural reconnaissance survey1/ of the proposed channel alignments in Garapan reported one potential archaeological site on the east-side of the Coastal Highway at the intersection of the Navy Hill road in a recently constructed sewer line trench. The outlet channel alignment through the American Memorial Park would avoid significant historic sites found by the National Park Service.

4.14 Social Resources. Approximately 340 structures are located in the flood prone areas of Garapan. The majority of residents in the area are native to Saipan and own the land on which their homes are built. They also view landownership as a commodity which can be bought, and as a vehicle of family solidarity and responsibility. The desire to own land is strong and results in a high market valuation of land on an island with limited land area. Many conflicts and confusion regarding landownership exist because the various land law systems which were imposed by non-native rulers created complex and contradictory sets of land records. Thus, many titles to private parcels are in dispute. A government study in 1977 indicated that there were about 3,500 homes on Saipan of which 2,000 were substandard and needed to be replaced. About 150 new homes a year were needed to meet housing demands on Saipan.

5. ENVIRONMENTAL EFFECTS.

5.1 Floodplain. The intercept of stormwater runoff from the upland areas and conveying the waters through flood prone areas in a channel would not be judged to have an adverse effect on the floodplain. The floodplain is a

1/ Pacific Studies Institute, Cultural Resources Reconnaissance for the Garapan Flood Control Study Area, March 1980.

developed area highly modified by previous activities, especially those related to World War II. Historic, wildlife, vegetation and water supply resources found in the floodplain are not dependent upon the floodplain for their existence. Relocating damageable properties from the floodplain affords an opportunity to preserve the floodplain possibly encouraging development uses compatible with the floodplain, such as open space parks and agriculture.

5.2 Groundwater. The groundwater in the Garapan area is not potable, and no municipal water supplies are located in the floodplain. All outlet channel alternatives will extend tidal waters inland, but will not affect potable water resources on Saipan. The relocation alternative does not modify waterways or tidal waters, and should not affect groundwater resources.

5.3 Water Quality. Water in the outlet channel will be lower in quality than water in the lagoons. The channel will be intermittent, flowing only when rainfall is significant enough to create runoff, and will be receiving waters for interior and upland drainage. Thus, the channel will accumulate trash, sediment, and a variety of urban stormwater pollutants, which will eventually be discharged into the lagoon.

The length of the channel will tend to act as a sediment trap and will require periodic dredging to maintain the channel depth. However, some of the finer sediment will remain suspended and carried into the lagoon when the channel is discharging. The turbid plume may be unnoticeable when the channel is flowing because rainfall over the island area will result in a large discharge of stormwater into Saipan from other village areas around Garapan. Sediment discharged from outlets located in Plans 1 and 3 will be carried northward in the lagoon, then offshore over the barrier reef at Puntan Muchot. Stormwater discharged in the American Memorial Park area may be confined to the area, minimizing its spread to other areas. Flow into Saipan Harbor and dredged areas around the Park is anticipated.

Salinity stress is expected to be confined to the nearshore area. Mixing should be adequate to prevent significant salinity variations on the barrier reef. Less than 50% of the water volume in the channel will be exchanged during each tidal cycle. This assumes that all the water within the tidal prism can exit the channel, and once out of the channel does not reenter the channel during the incoming tide. Under no flow conditions, water in the channel will be higher in temperature than lagoon waters, will contain higher levels of nutrients, particularly nitrogen, and will contain a high concentration of phytoplankton. Eutrophic conditions will most likely develop with oxygen levels increasing during daylight hours and decreasing during the night. Periodically, high volume rainfall will create flows strong enough to flush nutrient laden waters from the channel, essentially purging the channel. Plan 1 has the possibility of allowing cesspool and septic tank leachates into the channel, a condition that will contribute to eutrophic development in the outlet channel and possibly create a health hazard. Plan 2 has the potential of being a debris trap. The direction of the prevailing surface drift in Saipan Harbor is toward Puntan Muchot. Any floating trash from the harbor, which drifts into the Unai Sadog Tase area, may also drift into the channel and be trapped there. The direction of surface drift may also impede tidal flow out of the channel, further limiting water exchange in the channel.

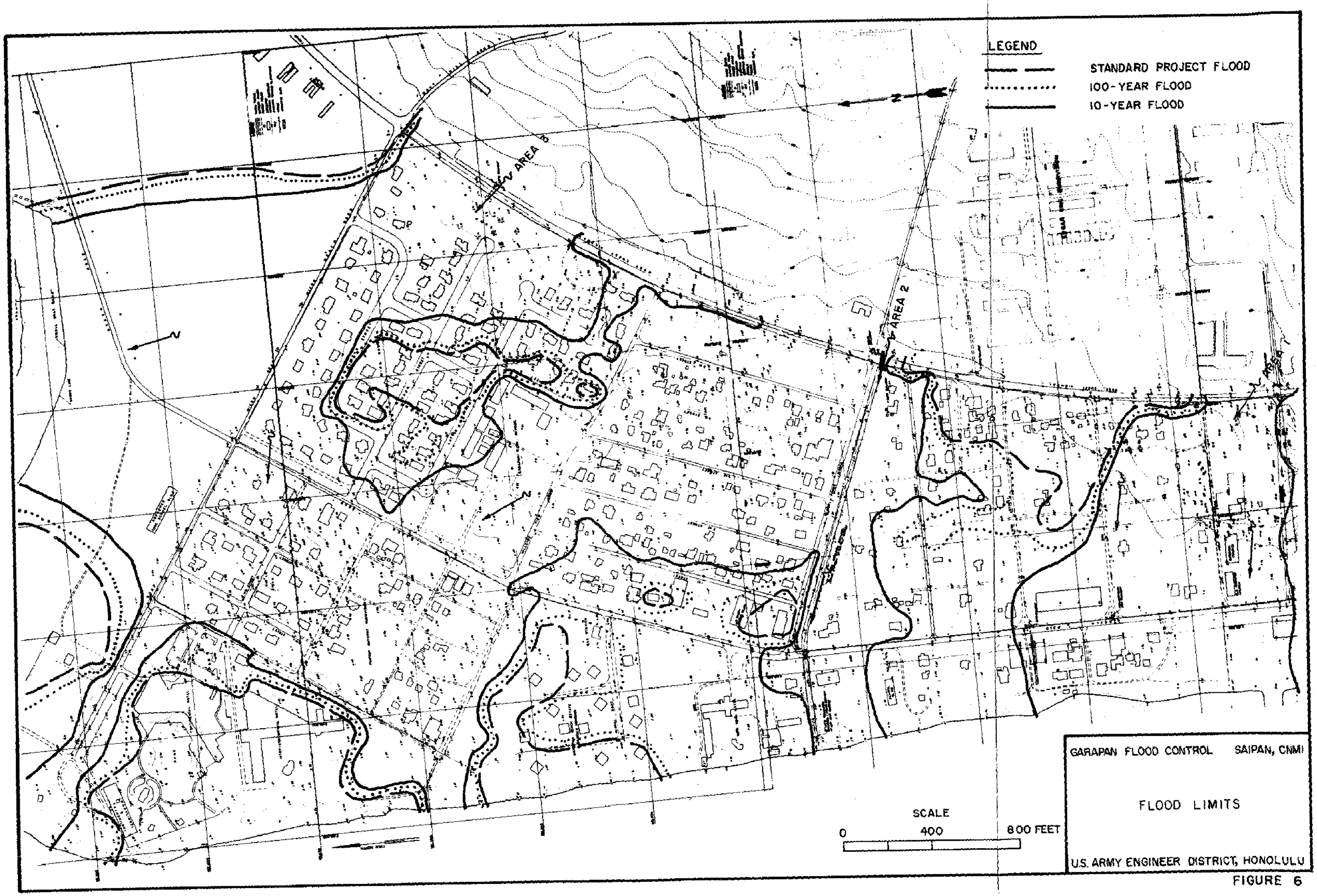

LEGEND
STANDARD PROJECT FLOOD
100-YEAR FLOOD
10-YEAR FLOOD
AREA 3
AREA 2
N
SCALE
0
400
800 FEET
GARAPAN FLOOD CONTROL SAIPAN, CNMI
FLOOD LIMITS
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 6

PRELIMINARY SCREENING

Applicable Nonstructural Measures. Because the existing use and proposed zoning (Figure 3) of the Garapan floodplain are primarily residential, preliminary analysis indicated that an essentially nonstructural plan is possible and would partially meet the planning objectives. A nonstructural plan consisting of relocating all existing damageable structures together with a program for local floodplain management has been carried out in the analysis. This plan is discussed further in subsequent sections. Analyses of other nonstructural measures showed that application of these measures would not provide a practical solution to the problems and needs (Table 2) of the Garapan area.

Flood prediction, warnings, preparation of temporary flood protection measures and temporary evacuation would help to decrease the flood damages. Because of the uncertainty of predicting hydrologic variables over a small drainage area, these methods of damage reduction for Garapan are not considered suitable. Floodproofing was found to be impractical in view of the large number of homes (nearly 300) of which the majority is the concrete block and slab type. Raising these structures to flood-free levels would require reconstruction of these structures on higher home site elevation which may be accomplished by filling. The concept of floodproofing therefore, was assessed on the basis of providing floodwalls, floodshields, and waterproofing coatings for these structures. The large number of property owners in the affected area, together with other nonstructural steps such as preparation to minimize inundation damages, temporary evacuation and reoccupation, would present many social and economic problems for the affected residents. Although floodplain regulation would control future development and thereby eliminate or reduce damages, this approach will not alleviate the existing flood problems in the developed areas.

Applicable Structural Measures. Various structural methods for alleviating the flood threat and preventing flood damages were considered. These included detention ponding; creating channelways and combinations of the above. Preliminary assessments indicated that due to the limited lands, ponding could not provide the necessary capacity and protection without channel or levee improvements. Consequently, alternative flood protection plans for Garapan consisting of diversion and outlet channels were developed for further consideration.

TABLE 2 - SCREENING OF POSSIBLE MEASURES

Measures	Preliminary Findings
Flood Warning/Temporary Evacuation	Predictions untimely and unreliable for small drainage areas.
Flood Proofing	Not practical. Adverse socioeconomic impact.
Permanent Evacuation and Relocation	High cost and adverse housing and social impact, but being considered further.
Floodplain Regulation	Does not alleviate the existing flood problems in developed areas.
Ponding Basins	Less favorable than other structural measures.
Channel-Levee Improvements	Has merit, should consider further.
Combination Nonstructural and Structural	Less desirable than structural measures from the equity standpoint.

PLAN FORMULATION RATIONALE

As defined earlier, flood mitigation is the primary objective of this study and the principal benefit values are considered generally basin-wide. Possible measures evaluated include nonstructural, structural and likely combinations of the two. Certain measures were subjected to preliminary investigations only because they were obviously less favorable than other measures in solving the flood problems. Some measures which have implementation possibilities were subjected to more studies to define their technical and economical feasibility, environmental impacts, and social acceptability. These factors are discussed in the following paragraphs.

Technical Criteria. Technical criteria established for plan formulation include consideration of alternative plans that can effectively reduce the flood problem or flood damage potential in the Garapan floodplain. The alternative plans should have dimensions adequate to provide a level of protection consistent with design and safety requirements.

Economic Feasibility. The alternative plans must be examined for economic feasibility. First, the quantifiable benefits should exceed project economic costs. Second, the project scope and scale should be formulated so that each alternative would maximize its net benefit effects. The economic analysis should be based on current prices, the adopted 50-year period of analysis, and at an interest rate of 7-1/8 percent.

Environmental and Social Acceptability. Environmental and social acceptability involved the identification, assessment, and evaluation of environmental resources and social effects which might be affected by a plan's implementation. Emphasis should be placed on avoidance of plans with severe natural resources, social, and health impacts. The views of the general public, particularly those of the Garapan residents, should be given careful consideration. Support from the public is a necessary item for plan implementation.

Preliminary Plans. In view of the lack of existing flood control improvements, and as a result of the preliminary screening of applicable measures, four preliminary alternative plans that could fulfill the planning objectives were developed. One is a nonstructural plan consisting of permanent relocation, and the other three are levee-channel alternatives.

ANALYSIS OF PRELIMINARY PLANS

Description of Plans 1, 2 and 3. Three structural channel plans which would provide protection for Garapan were investigated. Under each of these plans, a diversion channel located above West Coast Highway would be provided to convey floodwaters to an outlet channel which would discharge the flow into the ocean. These alternative plans are shown on Figures 7 through 9. Total length of channel improvements varies from 5,200 feet for Plan 1 to 6,000 feet for Plan 3. Common to all three plans is the 10 to 20 feet base width of the diversion channel. The outlet channel base width for Plan 1 would be 35 feet, Plan 2 at 30 feet, and 40 feet for Plan 3. In addition to relocation of existing utilities such as water and sewer lines, new culvert crossings will be required for all three plans. Plans 1 and 2 will require four new culverts, while Plan 3 requires five. Depending on the exact channel alignment, both Plans 1 and 3 may require relocating four residential structures.

Description of Plan 4. In view of the type of existing structures (mostly concrete blocks and slabs) discussed earlier, where elevating work will require substantial reconstruction, Plan 4 provides an alternate nonstructural possibility by permanent evacuation and relocation of residences to a flood-free area. Within the Garapan area, there are approximately 340 structures. This plan would necessitate the development and construction of new homes elsewhere, while the vacated lands would be retained for other passive use consistent with the flooding potential. In compliance with Section 73 of the Water Resources Development Act of 1974 (PL 93-251) which requires that consideration shall be given to nonstructural measures for flood damage prevention, and the President's water policy initiatives on non-structural alternatives, this permanent evacuation and relocation plan has been assessed and is presented in this document.

Impact Assessment and Comparison of Preliminary Plans. The structural alternative plans differ with respect to the outlet channel alignment and their impact on factors such as area of construction, location of floodwater discharge, concerns on natural, archaeological, and historic resources which might be affected and construction costs. Plan 1 provides for a shorter length of total channel improvements, and Plan 3 being the longest. No federal or local designated wildlife refuge, marine sanctuary will be affected by any of the channel plans. Potential impact on wetlands would be the greatest under Plan 2, especially within the proposed American Memorial Park site. Plan 2 may also affect or unearth World War II artifacts in the proposed park area. Due to the creation of the waterway, all structural plans will benefit migratory bird habitat. Since the outlet channel of Plan 2 does not traverse through the residential area, there will be no acquisition of privately-owned lands and relocation of residential structures will not be necessary. The economic factors, major environmental and social impacts are presented in Table 3 - Summary Comparison and System of Accounts. An evaluation of the discharge of dredged or fill material based on requirements of Section 404 of the Clean Water Act of 1977 is included in Appendix H - Compliance Documents.

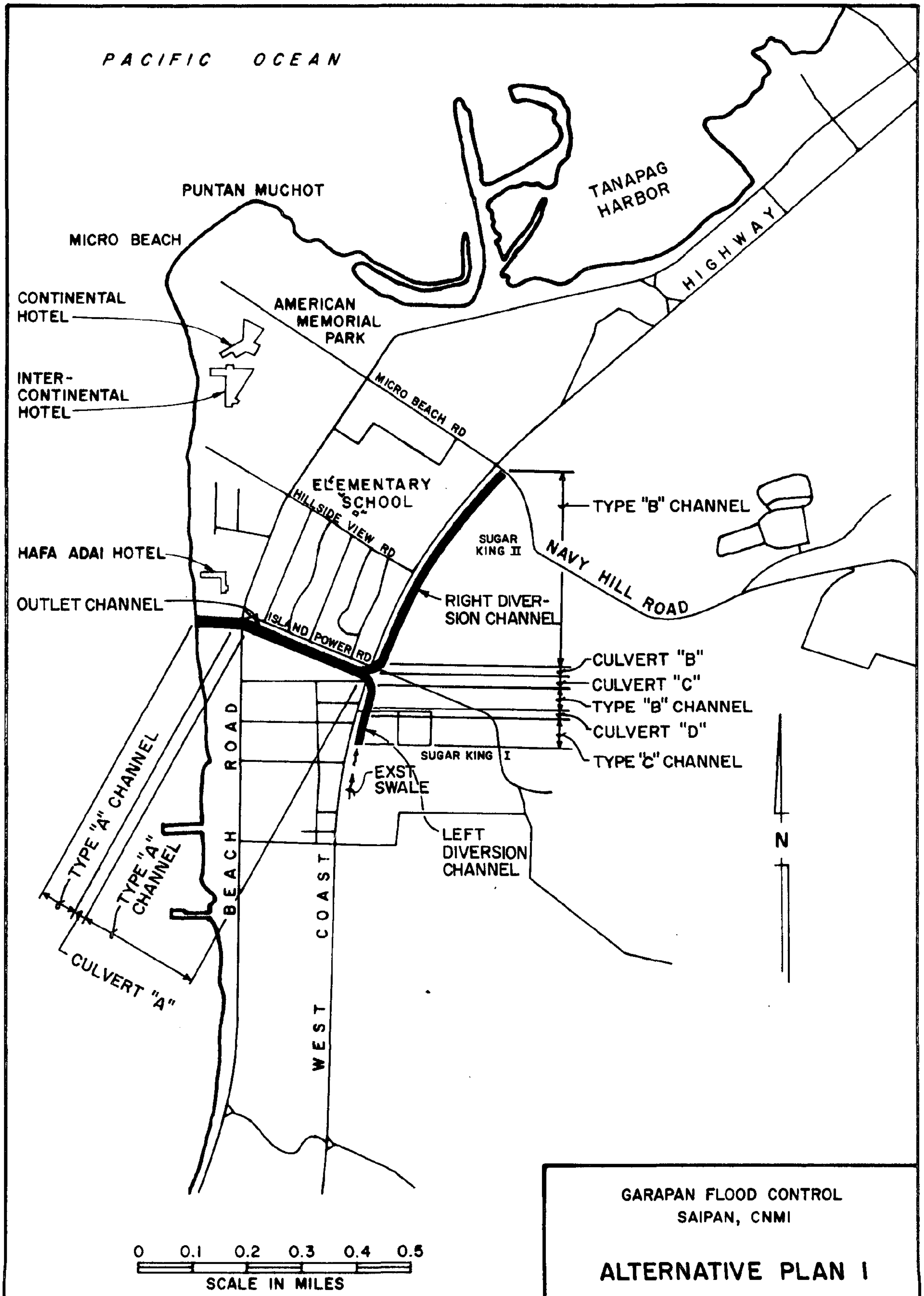
Plan 4 would have the least environmental impact. Investigations of permanent evacuation and relocation indicate that it is neither practicable nor economically feasible to move the residences of Garapan to another area on Saipan. Because of the shortage of available lands on a small island, high infrastructure development costs and social and cultural considerations associated with relocation, Plan 4 would present economic as well as social problems that cannot be justified. Preliminary cost estimate for evacuation and relocation is established at more than a million dollars. However, consistent with Corps planning requirements, this nonstructural plan is being carried through the study process and its significant beneficial and adverse impacts are displayed on Table 3.

On the basis that exceedence of the design flow would not endanger human lives in view of the low velocity and short-duration flows, no consideration was given to the standard project flood protection level. However, in compliance with engineering regulations, a detailed plan with protection against the 100-year is presented in Figures 10 and 12. The alignment for the 100-year plan is similar to Plan 2 with the outlet channel in the American Memorial Park area. To convey the higher flows and velocities, a major portion of the channel would be concrete-lined, in lieu of the grass-lined section utilized for the 50-year alternative plans. The average annual benefits and costs would be $267,000 and $476,000, respectively. The benefit to cost ratio is 0.6.

Of the four plans shown on Table 3, only Plans 1 and 2 are economically feasible. Plan 1, because of its larger net benefits, has been designated as the National Economic Development (NED) plan. Plan 4 appears to best meet the Environmental Quality (EQ) aspects by preserving the floodplain, and does not impact upon the wetlands and historic sites in the Garapan area. Accordingly, Plan 4 has been designated as the least environmentally damaging (LED) plan.

SCHEDULED WORK

The final selection of the most suitable and desirable plan will involve further comparison, tradeoffs, and public input. This work will be accomplished following the plan formulation public meeting scheduled for 30 July 1980, and review comments on this draft document. Additional sections to complete this Detailed Project Report are:



GARAPAN FLOOD CONTROL
SAIPAN, CNMI

ALTERNATIVE PLAN I

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 7

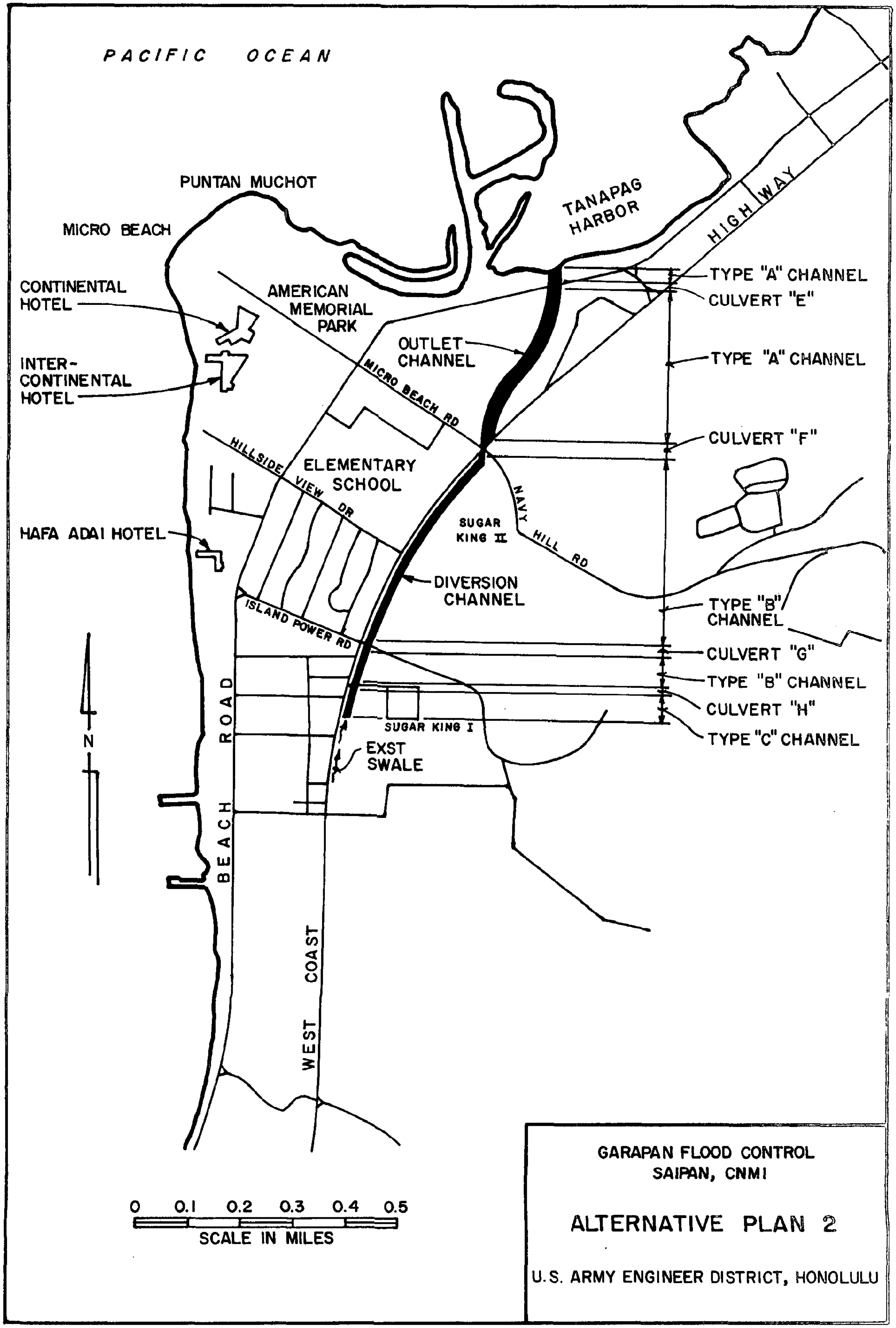
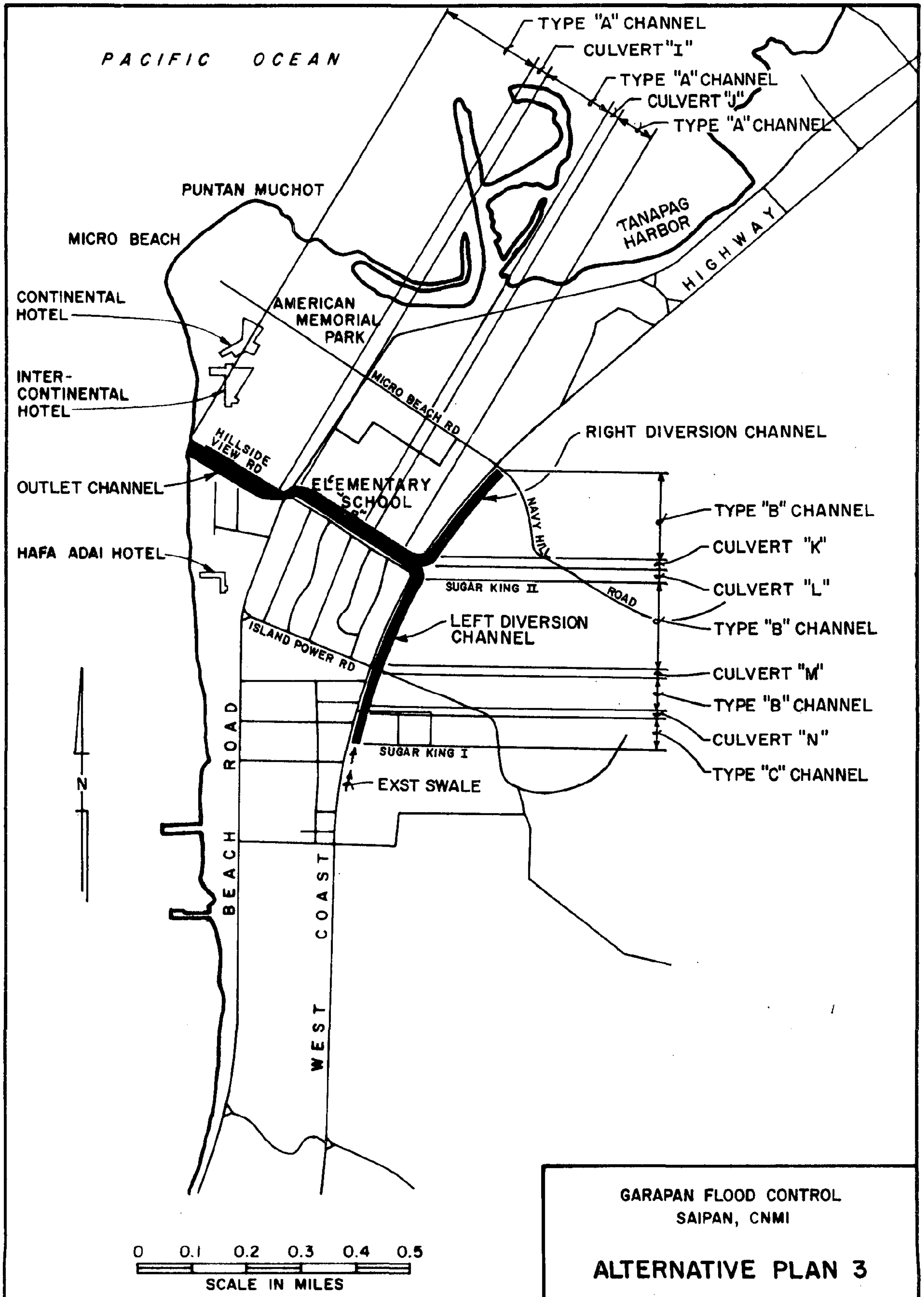

PACIFIC OCEAN
PUNTAN MUCHOT
MICRO BEACH
TANAPAG HARBOR
HIGHWAY
CONTINENTAL HOTEL
INTER-CONTINENTAL HOTEL
AMERICAN MEMORIAL PARK
OUTLET CHANNEL
MICRO BEACH RD
TYPE "A" CHANNEL
CULVERT "E"
TYPE "A" CHANNEL
CULVERT "F"
HILLSIDE VIEW DR
ELEMENTARY SCHOOL
SUGAR KING II
NAVY HILL RD
HAFA ADAI HOTEL
DIVERSION CHANNEL
ISLAND POWER RD
TYPE "B" CHANNEL
CULVERT "G"
TYPE "B" CHANNEL
CULVERT "H"
SUGAR KING I
TYPE "C" CHANNEL
EXST SWALE
N
BEACH ROAD
WEST COAST
0 0.1 0.2 0.3 0.4 0.5
SCALE IN MILES
GARAPAN FLOOD CONTROL
SAIPAN, CNMI
ALTERNATIVE PLAN 2
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 8

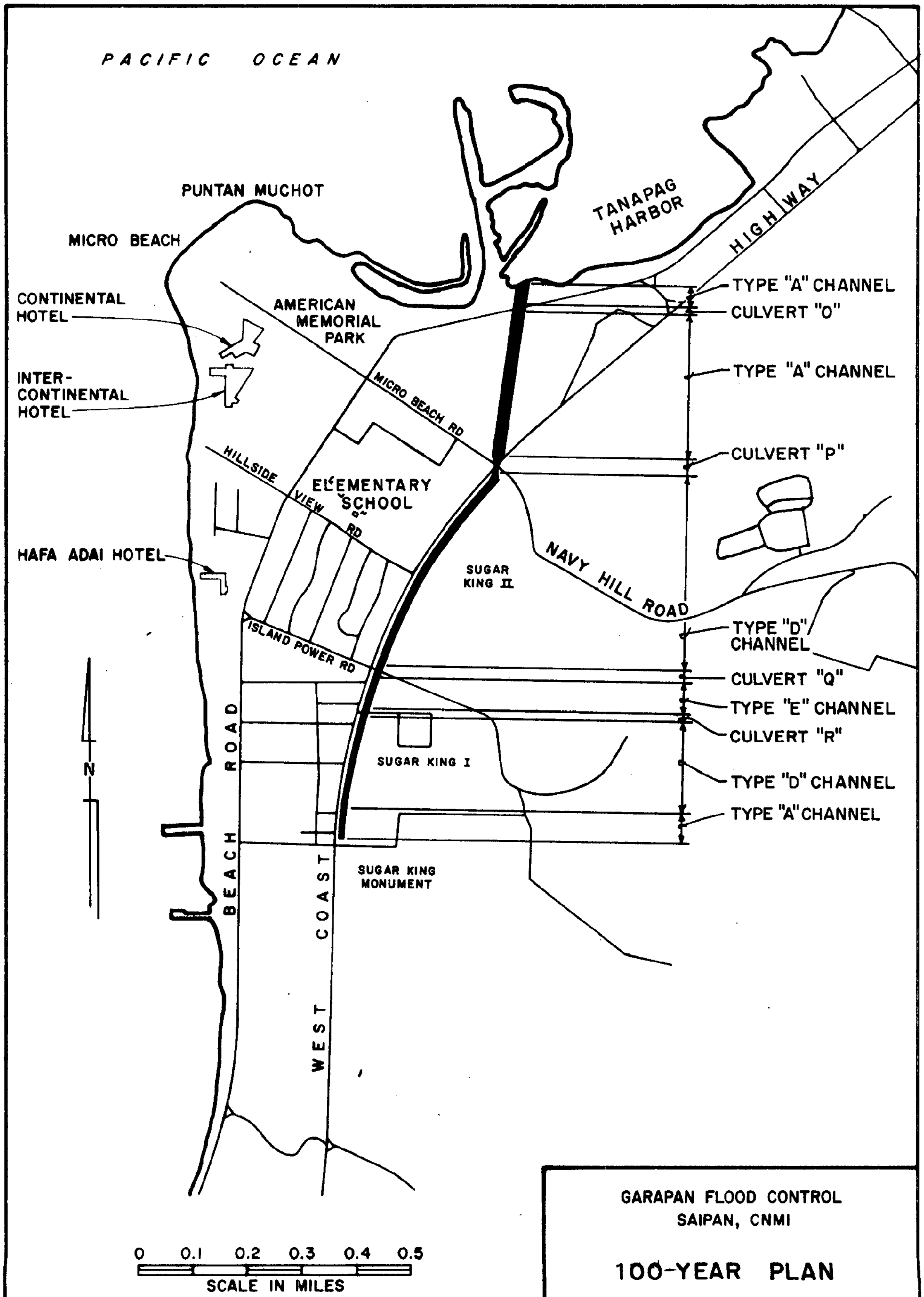


GARAPAN FLOOD CONTROL
SAIPAN, CNMI

ALTERNATIVE PLAN 3

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 9

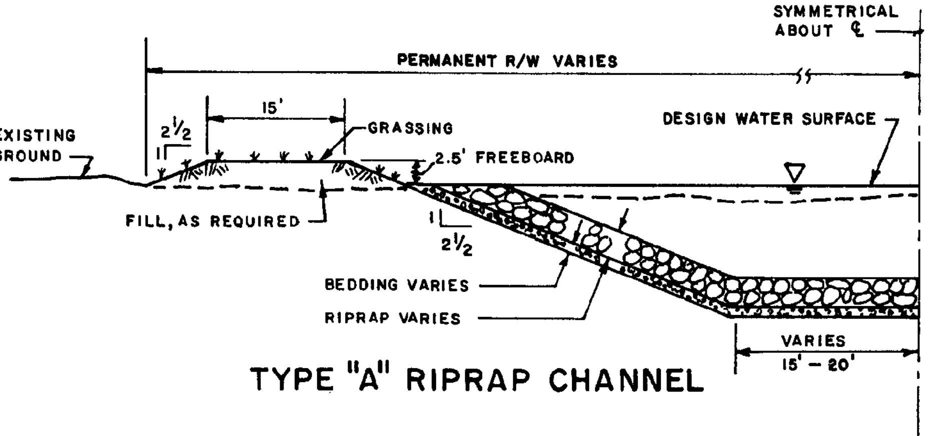


GARAPAN FLOOD CONTROL
SAIPAN, CNMI

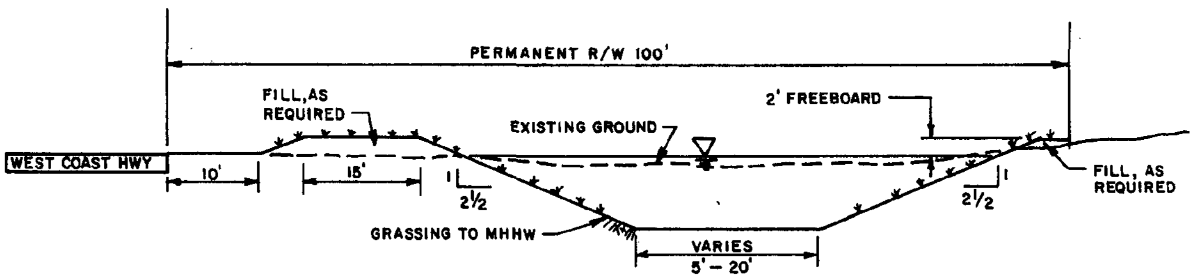
100-YEAR PLAN

U.S. ARMY ENGINEER DISTRICT, HONOLULU

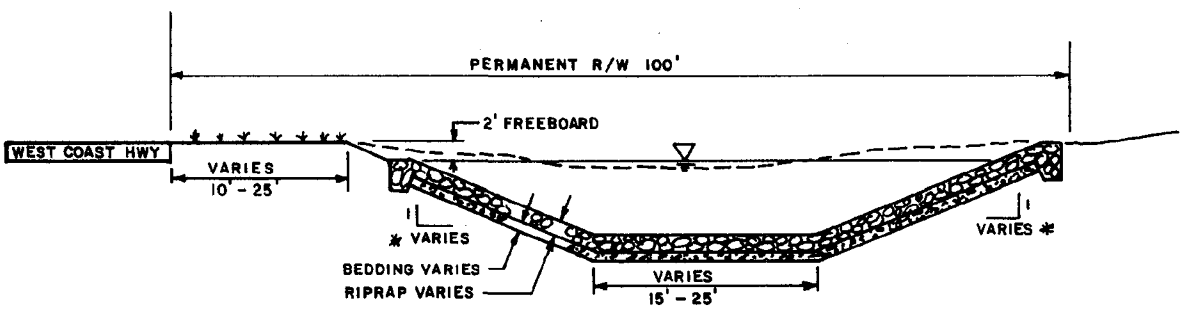
FIGURE 10



TYPE "A" RIPRAP CHANNEL



TYPE "B" GRASS LINED CHANNEL



TYPE "C" RIPRAP CHANNEL

SECTIONS NOT TO SCALE

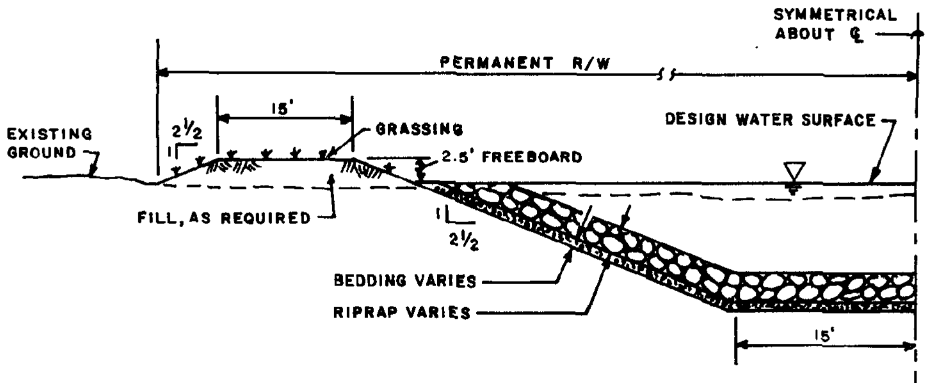
* SEE TABLE I

GARAPAN FLOOD CONTROL
SAIPAN, CNMI

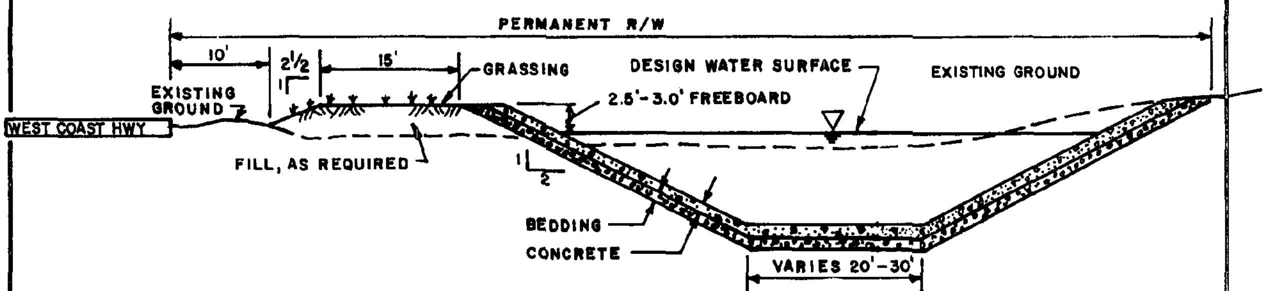
ALTERNATIVE PLANS I-3
TYPICAL CHANNEL SECTIONS

U.S. ARMY ENGINEER DISTRICT, HONOLULU

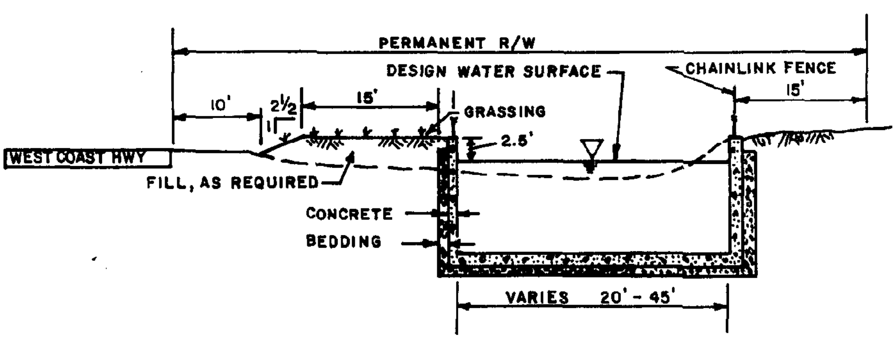
FIGURE 11



TYPE "A" RIPRAP CHANNEL



TYPE "D," TRAPEZOIDAL CONCRETE CHANNEL



TYPE "E," RECTANGULAR CONCRETE CHANNEL

SECTIONS NOT TO SCALE

GARAPAN FLOOD CONTROL
SAIPAN, CNMI

100-YEAR PLAN
TYPICAL CHANNEL SECTIONS

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 12

TABLE 3. SUMMARY COMPARISON AND SYSTEM OF ACCOUNTS

		WITH CONDITION			
	WITHOUT CONDITIONS	PLAN 1 CHANNEL WITH SAIPAN LAGOON OUTLET	PLAN 2 CHANNEL WITH AMERICAN MEMORIAL PARK OUTLET	PLAN 3 CHANNEL WITH GARAPAN SCHOOL OUTLET	PLAN 4 RELOCATION
A. PLAN DESCRIPTION	NO PROJECT	1,700-FOOT-LONG CHANNEL. CHANNEL DEPTH -6.0 FEET MSL AT MOUTH.	1,800-FOOT-LONG CHANNEL PASSES THROUGH PARK AND DISCHARGES INTO TANAPAG HARBOR. CHANNEL DEPTH -8.0 FEET MSL AT MOUTH.	2,500-FOOT-LONG CHANNEL DISCHARGES INTO SAIPAN LAGOON NEAR SCHOOL. CHANNEL DEPTH -8 FEET MSL AT MOUNTH.	ABOUT 340 STRUCTURES TO BE RELOCATED TO FLOOD-FREE AREA.
		ALL CHANNEL PLANS HAVE TRAPEZOIDAL CROSS-SECTION, RIPRAP OR GRASS LINING AND PROVIDE 50-YEAR PROTECTION. IN ADDITION TO THE OUTLET CHANNEL SHOWN ABOVE FOR EACH CHANNEL PLAN, A 3,500-FOOT DIVERSION CHANNEL. WOULD ALSO BE PROVIDED.			
B. SIGNIFICANT IMPACTS & PLAN RELATIONSHIPS TO NATIONAL ACCOUNTS					
1. ECONOMIC (NED)					
a. PROPERTY VALUES	INCREASING AT PREVAILING REAL ESTATE MARKET RATE.	SAME AS WITHOUT CONDITIONS. (2,6,9)	SAME AS PALN 1.	SAME AS PLAN 1.	INCREASE LIKELY. (1, 6, 9)
b. PUBLIC FACILITIES	DAMAGES TO FACILITIES AND INTERRUPTION OF SERVICES DURING FLOODING	NO SIGNIFICANT IMPACT WITH PLAN 1, 2, or 3 (2, 6, 9)			SIGNIFICANT DISRUPTION LIKELY. (1, 2, 5, 9)
c. DESIRED REGIONAL GROWTH	ADVERSE EFFECT IN FLOOD-PLAIN.	BENEFICIAL IMPACT IN FLOOD-PLAN. (2, 6, 9)	BENEFICIAL, BUT DISRUPT PARK DEVELOPMENT. (2, 6, 9)	SAME AS PLAN 1.	LONG-TERM GROWTH [illegible] ENHANCED, BUT DISRUPTION SIGNIFICANT (2, 6, 10)
d. BUSSINESS/INDUSTRIAL ACTIVITIES	DISRUPTION DURING FLOODING.	MINIMIZES DISRUPTION DURING FLOOD FLOW ON ROADS. (2, 6, 9).	SAME AS PLAN 1.	SAME AS PLAN 1.	INDIRECT DISRUPTION LIKELY DEPENDING ON RELOCATION SITE (1, 2, 5, 9)
e. FARM DISPLACEMENT	DISRUPTION DURING FLOODING.	NONE	NONE	NONE	DISPLACEMENT NOT LIKELY.
f. QUANTITATIVE ANALYSIS					
(1) BENEFICIAL IMPACTS ($1,000)					
(a) REDUCTION IN FLOOD DAMAGES	0	229.0	229.0	229.0	BENEFIT ANALYSIS NOT PERFORMED
(b) EDA BENEFITS	0	5.0	5.0	5.0	
(c) AFFLUENCE FACTOR	0	10.0	10.0	10.0	
(d) EMERGENCY SAVINGS	0	16.0	16.0	16.0	
(e) TOTAL NED BENEFITS		260.0	260.0	260.0	

(2) ADVERSE IMPACTS					
LOCAL		1,400	1,500	1,700	MORE THAN $10.0 MILLION. ANNUAL BENEFITS AND CHANGES NOT COMPUTED.
REST OF THE NATION		1,800	1,900	2,000	
O&M (LOCAL)		5.0	5.0	5.0	
TOTAL ANNUAL COSTS		241.0	255.0	277.0	
(3) NET NED BENEFITS					
LOCAL (ASSUME ALL BENEFITS ACCRUE TO LOCAL)		152.0	145.0	130.0	
NATION		(-)133.0	(-)140.0	(-)147.0	
NET NED BENEFITS		19.0	5.0	(-)17.0	
(4) B/C RATIO		1.08	1.02	0.94	
2. ENVIRONMENTAL (EQ)					
a. TERRESTRIAL ENVIRONMENT	INSIGNIFICANT CHANGE.	9.9 AC. MODIFIED	10 AC. MODIFIED	11.4 AC. MODIFIED	UNKNOWN. NEW RESIDENTIAL DEVELOPEMENT ELSEWHERE.
b. MARINE ENVIRONMENT	INSIGNIFICANT CHANGE.	1.9 AC CREATED 300 S.F. DREDGED	2 AC. CREATED 400 S.F. DREDGED	3.4 AC. CREATED 480 S.F. DREDGED	NO EFFECT.
c. ENDANGERED SPECIES	INSIGNIFICANT CHANGE.	NO EFFECT.	NO EFFECT.	NO EFFECT.	NO EFFECT ANTICIPATED.
d. WATER QUALITY	INSIGNIFICANT CHANGE.	TEMPORARY TURBIDITY AND SUSPENDED SEDIMENTS DURING CONSTRUCTION. WATER QUALITY IN THE OUTLET CHANNEL WILL BE LOWER THAN IN THE LAGOON. (1, 6, 9).	SAME AS PLAN 1.	SAME AS PLAN 1.	NO EFFECT ANTICIPATED.
e. HISTORIC	INSIGNIFICANT CHANGE.	POSSIBLE DAMAGE TO PREHISTORIC MIDDEN SITE. (1, 5, 9)			NO EFFECT ANTICIPATED.
f. WETLANDS	INSIGNIFICANT CHANGE.	POSSIBLE ENCROACHMENT ON WETLAND AREAS. (1, 5, 9)			NO EFFECT ANTICIPATED.
g. RECREATION	INSIGNIFICANT CHANGES.	FISHING OPPORTUNITIES INCREASE. (3, 6, 9)	SAME AS PLAN 1.	SAME AS PLAN 1.	GARAPAN AREA OPEN TO OPEN SPACE DEVELOPMENT.
3. SOCIAL (SWB)					
* a. HEALTH, SAFETY, & COMMUNITY WELL-BEING	DEGRADED DURING AND AFTER FLOODING. SEWAGE OVERFLOW OCCURS.	FLOOD-RELATED HEALTH AND SAFETY IMPROVED. COMMUNITY WELL-BEING ENHANCED. (2, 6, 9).	SAME AS PLAN 1.	SAME AS PLAN 1.	SAME AS PLAN 1.

* b. AESTHETIC VALUES	DEGRADATION OF LAND AND WATER QUALITY DURING AND AFTER FLOODING.	NEW VISUAL ELEMENTS ADDED CHANGING AESTHETIC CHARACTER OF AREA. (2, 6, 9).	SAME AS PLAN 1.	SAME AS PLAN 1.	SAME AS PLAN 1.
* c. AIR AND NOISE	INSIGNIFICANT CHANGE.	TEMPORARY DURING CONSTRUCTION. (1, 6, 9)	SAME AS PLAN 1.	SAME AS PLAN 1.	SAME AS PLAN 1.
* d. DISPACEMENT	DISPLACEMENT OF FAMILIES IN FLOODPLAIN DURING FLOOD.	FOUR HOMES DISPLACED; 5.0 AC. PRIVATE LAND PURCHASED (1, 5, 9).	NO DISPLACEMENT OF HOMES.	FOUR HOMES DISPLACED: 4.8 AC. OF PRIVATE LAND PURCHASED. (1, 5, 9)	340 STRUCTURES RELOCATED. GOVERNMENT LAND USED.
* e. COMMUNITY COHESION	INSIGNIFICANT CHANGE.	NO CHANGE.	SAME AS PLAN 1.	SAME AS PLAN 1.	DISRUPTED WITH RELOCATION.
* 4. REGIONAL DEVELOPMENT (COMMUNITY GROWTH)	ADVERSE EFFECT ON DEVELOPMENT WITH FLOODPLAIN.	IN CONFORMANCE WITH REGIONAL DEVELOPMENT PLAN (2, 5, 8, 9).	SAME AS PLAN 1.	SAME AS PLAN 1.	SAME AS PLAN 1.
C. PLAN EVALUATION					
1. CONTRIBUTION TO PLANNING OBJECTIVES					
a. CONTRIBUTE TO THE REDUCTION OF FLOOD-WATER DAMAGE DURING THE 1985-2035 PERIOD OF ANALYSIS.	CONTINUED FLOODING AND FLOOD DAMAGES.	REDUCTION IN FLOOD DAMAGES TO RESIDENTIAL STRUCTURES.	SAME AS PLAN 1.	SAME AS PLAN 1.	SAME AS PLAN 1.
b. PRESERVE THE NATURAL RESOURCES OF THE AREA DURING THE 1985-2035 PERIOD OF ANALYSIS.	NO CONTRIBUTION.	PARTIALLY CONTRIBUTION.	PARTIAL CONTRIBUTION.	PARTIAL CONTRIBUTION.	MOST CONTRIBUTION.
2. RESPONSE TO ASSOCIATED EVALUATION CRITERIA 1/					
a. ACCEPTABILITY	N/A	TO BE COMPLETED FOLLOWING PUBLIC REVIEW OF DOCUMENTS AND PUBLIC MEETINGS.			
b. EFFECTIVENESS	N/A	MODERATELY HIGH	MEDIUM	MODERATELY HIGH	HIGH
c. EFFICIENCY	N/A	LEAST COST	MEDIUM	LOW	VERY LOW WITH HIGHEST COST.
d. NED B/C RATIO	N/A	SEE ITEM B.1.f(4)			
e. STABILITY	N/A	MODERATE	MODERATE	MODERATE	UNKNOWN
1/ SPECIFIC CRITERIA OF COMPLETENESS, CERTAINTY, GEOGRAPHICAL RELEVANCY, AND REVERSIBILITY NOT CRUCIAL TO DECISION-MAKING.					
3. IMPLEMENTATION	N/A	CORPS OF ENGINEER/CNMI	SAME AS PLAN 1.	SAME AS PLAN 1.	SAME AS PLAN 1.

INDEX OF FOOTNOTES

TIMING
1. IMPACT IS EXPECTED TO OCCUR PRIOR TO OR DURING IMPLEMENTATION OF THE PLAN.
2. IMPACT IS EXPECTED WITHIN 15 YEARS FOLLOWING PLAN IMPLEMENTATION.
3. IMPACT IS EXPECTED IN A LONGER TIME FRAME (15 OR MORE YEARS FOLLOWING IMPLEMENTATION).

UNCERTAINTY
4. THE UNCERTAINTY ASSOCIATED WITH IMPACT IS 50% OR MORE.
5. THE UNCERTAINTY IS BETWEEN 10% AND 50%.
6. THE UNCERTAINTY IS LESS THAN 10%.

EXCLUSIVITY
7. OVERLAPPING ENTRY: FULLY MONETIZED IN NED ACCOUNT.
8. OVERLAPPING ENTRY: NOT FULLY MONETIZED IN NED ACCOUNT.

ACTUALITY
9. IMPACT WILL OCCUR WITH IMPLEMENTATION.
10. IMPACT WILL OCCUR ONLY WHEN SPECIFIC ADDITIONAL ACTION ARE CARRIED OUT DURING IMPLEMENTATION.
11. IMPACT WILL NOT OCCUR BECAUSE NECESSARY ADDITIONAL ACTIONS ARE LACKING.

*ITEMS REQUIRED BY SECTION 122, PUBLIC LAW 91-611 AND ER 1105-2-240.

1. Main Report.

a. Assessment and Evaluation of Detailed Plans.

b. Plan Implementation and Public Views.

c. Conclusion (including Statement of Finding and Recommendations).

2. Appendices.

a. Subsurface investigations, laboratory tests, and design values in Appendix B - Geology and Soils.

b. Detailed hydraulic designs and cost estimated in Appendix C - Engineering, Investigations, Design and Cost Estimates.

c. Economics of the selected plan in Appendix D - Economics.

d. Draft report and environmental statement review, and report comments and responses in Appendix F - Public Involvement.

e. Fish and Wildlife 2(b) report in the Environmental Statement.

f. Compliance certification and evaluation reports as required in Appendix H - Compliance Documents.

GARAPAN FLOOD CONTROL

SAIPAN, CNMI

ENVIRONMENTAL IMPACT STATEMENT

DRAFT

ENVIRONMENTAL STATEMENT

GARAPAN FLOOD CONTROL PROJECT, GARAPAN SAIPAN, COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

The responsible Commonwealth agency is the Coastal Resources Management Office. The lead federal agency is the US Army Corps of Engineers, Honolulu District. The cooperating federal agency is the US Fish and Wildlife Service, Pacific Islands Office.

Abstract: Saipan is the main island in the Commonwealth of the Northern Mariana Islands. The Honolulu District, US Army Corps of Engineers, has investigated public concerns regarding flood protection in the village of Garapan on Saipan. Channelizing the floodflow and permanent evacuation and relocation are the alternative concepts being studied. The channel alignments all include a channelized section along the eastern edge of the West Coast Highway, involving one of three different outlet alignments. The alignment for Plan 1 involves the discharge of stormwater into Saipan Lagoon near the Hafa Adai Hotel. The alignment for Plan 2 conveys water through the proposed American Memorial Park. The outlet alignment for Plan 3 is adjacent to an existing roadway alongside Garapan Elementary School. A relocation plan, Plan 4, involves the physical removal of all damageable structures located in the floodplain. No area for relocation has been identified.

SEND YOUR COMMENTS TO THE DISTRICT ENGINEER BY 15 SEPTEMBER 1980.

If you would like further technical information about this statement, please contact:

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The intertidal mudflats created in the channel may create an odor nuisance within the community. Plan 2 located in the park has the least possibility of affecting residential areas, but will degrade park aesthetics. Waters exiting the channel will create a localized area of nutrient enrichment in Saipan Lagoon, possibly invigorating the growth of seagrass at the channel outlet. Approximately 300 square feet of lagoon habitat will be dredged at the mouth of the channel. The excavation of about 1,200 cubic yards of sand and coralline material will contribute to a temporary increase in water turbidity in the lagoon. The extent of the effect is grossly estimated by the length of time necessary to complete the dredging and the quantity of material to be removed. In all cases, the material to be removed consists of coralline fines, sand and rubble.

The relocation alternative does not directly affect water quality. Urban stormwater runoff will be increased from the developed site once the developed site is paved, and sediment eroded from open areas will eventually find its way to manmade or natural drainageways. The new urban area will most likely be sewered, improving sanitation conditions as well as eliminating health problems related to overflowing or flooded cesspools or septic tanks.

5.4 Littoral Processes. Longshore sand movement is not evident at the Garapan shoreline. Garapan Dock still has 12-foot depths around it and a channel north of the harbor near Puntan Muchot is still evident in aerial photographs. This indicates that the channel mouth does not and probably will not shoal at a fast rate or interrupt littoral drift. Although a sandbar has formed at the mouth of the existing drainage ditch next to the Hafa Adai Hotel, the bar may have be formed by onshore and offshore sand movement during significant storm events.

Shoaling in the channel due to sedimentation from upland sources is anticipated and will require periodic maintenance dredging of the channel. If a bar does form across the channel mouth, the water trapped behind the bar will stagnate, and periodic clearing will be required to maintain the channel. Plans 1 and 3 may have a greater possiblity of shoaling at the channel mouth than Plan 2, where the channel outlets into Unai Sadog Tase (Unai Sadog Tase is a quiet water cove in the harbor formed by the filled shoreline and dredged causeways). The relocation alternative does not affect littoral processes.

5.5 Wetlands. The diversion channel alignment has the potential of destroying a portion of a wetland which was identified during an ornithological survey of Saipan wetlands. The location of the wetland is uncertain in that it conflicts with the location identified by a wetland survey conducted by the University of Guam. The diversion channel will be excavated in a portion of the wetland converting the wetland to a dry habitat. The wetland is already divided by the West Coast Highway and may be formed by a lack of drainage past the highway. The channel alignment through the American Memorial Park passes around the park wetland and avoids the wetland. However, the channel section passing the wetland area will be made impervious to prevent the exchange of water between the wetland and channel, or the drainage of the wetland. The relocation alternative avoids any construction in the wetlands.

5.6 Migratory Shorebirds. Migratory shorebirds may profit by the creation of more intertidal area within the channels. Cleared, grassed open areas within the channel will provide resting and feeding areas for some of the birds. The riprap outlet channel and channel intertidal area will also provide feeding and resting habitat. The relocation alternative is not expected to affect migratory shorebirds.

5.7 Lagoon Resources. The outlet channel requires excavation of a small area near the shoreline in the lagoon. The area disturbed for each plan is estimated on Table 2. Dredging will result in the loss of some Enhalus seagrass. Nutrients exiting the channel during tidal flushing and periods of flow may stimulate a growth of seagrass and algae at the mouth of the channel. Fish will colonize the outlet channel and the channel may become a nursery area for fisheries resources. The amount of new marine habitat created by each plan is estimated on Table 2. The relocation alternative does not affect Saipan Lagoon.

5.8 Endangered Species. None of the alternatives are likely to jeopardize the continued existence of the threatened Green Sea Turtle which has been seen in Saipan Lagoon. The shoreline areas and the lagoon are not known to be nesting or breeding habitats for the turtle. Loss of the American Memorial Park wetland will most likely force the Nightingale Reed Warbler into other wetland areas on Saipan.

5.9 Recreation. The channel alternatives will create an 8-foot water depth along the shoreline which will interrupt pedestrian movement along the beach. The channel alignment through the park will divide the parklands into two sections inhibiting free movement between the two sections. The channel may attract fishermen and children who want to catch fish. The outlet channel alignment in Plan 3 passes alongside Garapan Elementary School and may create a nuisance to the school. The channel will be about 2 feet deep at that point and will have a side slope of 1 vertical to 2.5 horizontal and thus should not create a hazard at the school. The diversion channel will be a grass swale along the boundary of the proposed site of the junior high school and is not expected to interfere with recreation activities at the school. The relocation alternative opens up more coastal land for potential park development and increased recreational areas, provided that the relocation area is not located within a potential recreation area.

5.10 Historic Resources. The channel alternatives involve a diversion channel upland of the West Coast Highway. An archaeological midden site was found along the channel alignment in an area recently excavated for a sewerline construction near the Navy Hill Road intersection with the West Coast. The Commonwealth Historic Preservation Officer was asked to determine if the site was destroyed by the sewerline construction and for his opinion regarding the eligibility of the site to the National Register of Historic Places. The site is the first prehistoric site found in the Garapan area, and, if still present, has the potential of yielding scientific data important to understanding the prehistory of Saipan and the Garapan area. Excavation of the channel may destroy the site, resulting in the loss of scientific data. Plan 2 outlet channel alignment passes through the Memorial Park which was set aside in commemoration of those who fought and died in the Marianas Campaign during World War II. The channel is not expected to disturb historic sites in the park found by the National Park Service's survey, but war artifacts could be uncovered during construction. Since the location of the relocation site has not been identified, the impacts of relocation on historic sites cannot be discussed.

5.11 Social Resources. The relocation alternative involves approximately 340 structures. Social disruption would be significant, especially for those families who see landownership as a family bond. Those persons, who view landownership as a commodity to be bought and sold, will ask an extremely high price for their land and homes. The complex and contradictory set of land records and titles may make settlement with landowners a long and tedious process with many disputes. The government would have to find a relocation site that could be developed to provide homes and land for displaced families. The proposed Sugar King subdivision on the hillside overlooking Garapan may be a likely location for resettlement. However, relocating residents from Garapan into the new subdivision reduces the number of housing units the government is trying to make available to families who do not own their own homes and live in substandard structures.

6. PUBLIC INVOLVEMENT

6.1 Public Involvement Program. Project detailed design investigations were performed with the assistance of the Commonwealth Coastal Resources Management, Department of Public Works, and Mariana Islands Housing Authority. A survey of damageable property within the flood prone area was conducted on Saipan by Corps personnel. A public notice advising the public of the study and announcing a public workshop was circulated on Saipan in February 1979. The public workshop was held on Saipan in March 1979 and approximately 20 persons participated in the workshop.

6.2 Required Coordination. The following coordination needs to be completed prior to finalizing the report and environmental impact statement. Coordination to be satisfied by circulation of the EIS for review and comment is identified by an asterisk.

a. Section 404. A water quality certification must be obtained from the Commonwealth, Division of Environmental Quality. An evaluation of the discharge of dredged or fill material was completed using the US Environmental Protection Agency Section 404 (b)(1) guidelines (see Appendix H) and is provided for agency review.

b. Endangered Species Coordinator. US Fish and Wildlife Service and the National Marine Fisheries Service will have an opportunity to review and comment on the Draft EIS. Formal consultation will not be initiated under Section 7 of the Endangered Species Act of 1978.

c. Fish and Wildlife Coordination. The US Fish and Wildlife Service, National Marine Fisheries Service, and the Commonwealth Department of Natural Resources will have an opportunity to review and comment on the report/EIS. The US Fish and Wildlife Service will prepare a report under Section 2(b) of the Fish and Wildlife Coordination Act expressing their opinion regarding the project and the conservation, preservation or protection of fish and wildlife resources. The report will be included in the final report/EIS.

d. Historic Preservation. The results of the archaeological reconnaissance survey of the project site are being coordinated with the

Commonwealth Historic Preservation Office. The Historic Preservation Officer will provide his opinion about the eligibility of the archaeological site and may provide a determination of effect under the National Historic Preservation Act of 1966.

e. Coastal Zone Management. The Office of Coastal Zone Management will have an opportunity to review and comment on the draft report/EIS. An approved Coastal Zone Management Plan is not in effect in the Commonwealth; thus a federal consistency certification is not required until the Commonwealth Coastal Management program is approved.

f. Floodplain Management. The public will have an opportunity to review and comment on the effects of the project on the floodplain. An evaluation of the project on the floodplain will be included in Appendix H after a tentative recommended plan has been selected.

6.4 Statement Recipients. The following agencies and individuals were provided copies of the draft Detailed Project Report and Draft Environmental Statement for review and opportunity to comment.

a. Federal.

U.S. Environmental Protection Agency (Washington & Region IX)
U.S. Department of Commerce
    National Marine Fisheries
U.S. Advisory Council on Historic Preservation
U.S. Department of Interior
    National Park Service
    U.S. Fish and Wildlife Service
U.S. Department of Housing and Urban Development
U.S. Department of Health, Education and Welfare
U.S. Department of Transportation
    Federal Highway Administration
    U.S. Coast Guard
U.S. Department of Energy

b. Commonwealth.

Office of the Governor
Department of Public Works
Mariana Islands Housing Authority
Commonwealth Historic Preservation Officer
Department of Natural Resources
Officer of Planning and Budget
Mayor of Saipan
Division of Marine Resources Development
Division of Environmental Quality
Office of Coastal Resources Management
Marianas Public Land Corporation
Department of Public Health

6.5 Public Views and Responses. To be completed following the review period for the Draft EIS.

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SAIPAN, COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

GARAPAN FLOOD CONTROL STUDY
SAIPAN, COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

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Unresolved Issues	Para 1.3, P 1	
Without Conditions (No Action)	Para 3, PP 5-8	P 7

8.LIST OF REFERENCES*

1. Amesbury et al., A Survey of the Fish Resource in Saipan Lagoon, prepared for the Office of Coastal Zone Management, CNMI, University of Guam Marine Lab., Technical Report No. 50, March 1979 (Contract #579-02)

2. Coastal Zone Management Office, Preliminary Draft Natural Resources Study, Commonwealth of the Northern Mariana Islands, Office of Planning Budget, CNMI, Feb 1979

3. Cloud et al., Geology of Saipan, Mariana Islands, U.S. Geological Survey Professional paper 280A, Parts 1-4, 1955 and 1959

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7. M&E Pacific, Inc., Facilities Plan for the Island of Saipan, Mariana Islands, prepared for the Department of Public Works, GNMI, March 1979

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9. Office of Planning and Statistics, Bulletin of Statistics, Vol 1, No. 3, Trust Territory of the Pacific Islands, Dec 1978

10. Pacific Planning and Design Consultants, Physical Development Master Plan, Vol. II Saipan, prepared for the Office of Transition Studies and Planning, GNMI, Jan 1978

11. Pacific Studies Institute, Cultural Resources Reconnaissance, for the Garapan Flood Control Study Area, Commonwealth of the Northern Mariana Islands, prepared for U.S. Army Corps of Engineers, Pacific Ocean Division, March 1980, Contract No. DACW84-79-C-0028, and Archaeological Reconnaissance of the Armerican Memorial Park, Saipan, Commonwealth of the Northern Mariana Islands, for the National Park Service, November 1979.

12. Robert R. Nathan Associations, Inc., Socio-economic Development Plan for the Northern Mariana Islands, 1978 to 1985, Vols I, II, and III, prepared for the Office of Transition Studies and Planning, GNMI, Oct 1977

* For EIS and Appendix G, Recreation and Natural Resources

GARAPAN FLOOD CONTROL
SAIPAN, CNMI

HYDROLOGY

APPENDIX A

HYDROLOGY APPENDIX

TABLES

PLATES

HYDROLOGY

GARAPAN AREA, SAIPAN

COMMONWEALTH NORTHERN MARIANA ISLANDS

INTRODUCTION

1. Scope. This appendix contains descriptions of studies made to determine the runoff process for various selected concentration points within the Garapan watershed which has a total drainage area of 1.89 square miles (Plate A-1). There are four objectives of this appendix: (a) to present the basic meteorologic and hydrologic characteristics of the study area; (b) to outline the methods and techniques used to determine the runoff process; (c) to present discharge frequency values for the present and future (project and no-project) conditions; and (d) to provide standard project flood, 100-year, and 50-year design discharges for the alternative flood control plans.

2. Alternative Flood Control Plans. Four conceptual schemes were investigated, three plans are structural alternatives and the other a nonstructural alternative. All structural alternatives consist of a diversion channel system above West Coast Highway and an outlet channel in various locations. While all the schemes were hydrologically analyzed, only the results for alternative 1 are discussed and displayed graphically. The design concepts for all alternatives are stated in the main report.

GENERAL DESCRIPTION

3. Hydrologic Data. Due to a paucity of hydrologic information on the Garapan watershed and the island of Saipan, a reliable investigation was deemed possible only with the use of data from other areas which were judged to be hydrologically similar to Saipan and the Garapan watershed. The nearest source of dependable hydrologic information is the island of Guam. Both of the islands belong to the Mariana Island formation, with Guam located 120 miles south of Saipan. Both islands also lie within the same band of typhoon and tropical storm exposure according to the report prepared by the Bureau of Planning, Government of Guam, entitled "Typhoons: Their Nature and Effects on Guam," December 1977. These typhoons and tropical storms produce intense rainfalls and are the primary storm events of the rainy season which occurs from July through October. Since there are similarities between drainage area sizes, topography, geology, and meterology of the Garapan watershed and the watersheds in Guam, it was assumed that they would also be hydrologically similar.

4. Methodology. Areas 1, 2, and 3 (plate A-1) are topographically similar to the Guam and Saipan watersheds having recorded hydrologic data. Therefore these areas were analyzed by the direct use of the results obtained

in the hydrologic analysis of the recorded data. Discharge-frequency curves were developed by the application of regression equations which were developed from a regression-correlation analysis of peak discharge-frequency data. The Standard Project Flood was constructed by applying unit hydrographs described by Snyder's Unit Hydrograph Parameters to the Standard Project Storm hyetograph.

5. Areas 1A, 2A and 3A are unlike the gaged watershed. They are relatively developed and lie on the flat coastal plain which is marked with many depressions. To account for the differences, modificatons were made to the analytic computations of the gaged watersheds. The primary changes made were the recomputation of the time of concentration and lag time. These changes were incorporated in determining the discharge-frequency curves and the SPF hydrographs for areas 1A, 2A and 3A and are described in greater detail in Paragraph 13.

SPF FLOOD HYDROGRAPH DERIVATION

6. Unit Hydrographs. Snyder's Unit Hydrograph Parameters, used for the Garapan watershed analysis, were obtained from a report entitled, "Survey of Harbors and Rivers in the Territory of Guam, Ugum River - Derivation of Probable Maximum Flood," 17 November 1978, which was prepared by the US Army Corps of Engineers, Pacific Ocean Division (POD). The report derived a unit hydrograph for the 4 December 1963 flood in the Umatac River watershed, the only watershed in Guam with a recording rain gage and a continuous water-stage recorder. This unit hydrograph was assumed to be representative of the hydrologic response of the watersheds in Guam, and therefore, Saipan. The 1963 storm data were analyzed by HEC-1, a flood hydrograph computer program developed by the Hydrologic Engineering Center (HEC), US Army Corps of Engineers. The following Snyder's Unit Hydrograph Parameters, were computed: $C_p = 0.64$, and $C_t = 0.34$. Regional curves defining the unit hydrograph widths, W75 and W50, were developed by drawing lines parallel to the standard curves shown in EM 1110-2-1405 through points described by the computed unit hydrograph (Peak Q = 2,100 cfs, D.A. = 2.11 square miles, Peak Discharge per square mile = 995 cfs per square mile, W75 = 0.38 hours, and W50 = 0.60 hour). By applying the Guam based unit hydrograph data to the physical dimensions of the Garapan drainage areas, 10 minute unit hydrographs for Garpan were developed. A 10-minute time interval was chosen since it provided adequate description of the unit hydrographs. In accordance with EM 1110-2-1405, the peaks of the unit hydrographs were increased to account for differences noted in past analyses of minor and major floods. A 50 percent increase was selected in this study. Plates A-2 and A-3 shows the unit hydrographs used to develop the SPF for the Garapan watershed. Plate A-4 depicts the regional W75 and W50 curves used to shape the unit hydrographs. Tables A-1 and A-2 summarizes the unit hydrograph calculations. The applicability of the derived unit hydrographs to model the Garapan watershed is discussed in Paragraph 25; "VERIFICATION OF HYDROLOGIC INVESTIGATION."

TABLE A-1. UNIT HYDROGRAPH PARAMETERS

	WATERSHED CHARACTERISTICS				
	DA (SQMI)	L (MILE)	L_{CA} (MILE)	C_t	$640C_p$
Area 1	0.68	1.85	1.03	0.34	410
Area 2	0.28	0.99	0.49	0.34	410
Area 3	0.50	1.42	0.70	0.34	410

	10-MINUTE UNIT HYDROGRAPH			
	Q_{pr} (cfs)	t_{pr} (Minute)	W-75 (Minute)	W-50 (Minute)
Area 1	640	26.1	22.8	40.8
Area 2	380	18.0	16.3	25.8
Area 3	560	21.9	20.0	31.6

	PEAK INCREASED BY 50 PERCENT 10-MINUTE UNIT HYDROGRAPH			
	Q_{pr} (cfs)	t_{pr} (Minute)	W-75 (Minute)	W-50 (Minute)
Area 1	960	17.4	15.9	25.2
Area 2	570	12.2	10.8	17.1
Area 3	840	14.6	12.9	20.7

	PEAK INCREASED (FUTURE CONDITION) 10-MINUTE UNIT HYDROGRAPH			
	Q_{pr} (cfs)	t_{pr} (Minute)	W-75 (Minute)	W-50 (Minute)
Area 1	640	26.1	22.8	40.8
Area 2	500	13.7	12.0	19.2
Area 3	650	18.8	16.8	27.0

TERMINOLOGY

DA: Drainage area of the watershed

L: Length of the longest watercourse from the outflow point to the upstream watershed boundary.

LCA: Length along the longest watercourse from the outflow point to the point nearest the centroid of the watershed.

C_t and $640C_p$: Regional coefficients which represent the basin slopes, stream patterns, basin shape, and other properties.

Q_{pr}: Peak discharge of the unit hydrograph.

t_{pr}: Time between the mid-point of 1 inch rainfall excess and the peak discharge of the unit hydrograph.

W-75: Width of the unit hydrograph at the ordinate that equals 75% of the peak discharge.

W-50: Width of the unit hydrograph at the ordinate that equals 50% of the peak discharge.

TABLE A-2. UNIT HYDROGRAPH FOR LOCAL DRAINAGE

	EXISTING CONDITION WATERSHED CHARACTERISTICS				
	DA (SQ MI)	L (MILE)	L_{CA} (MILE)	SLOPE (FT/FT)	T_c (MINUTES)
Area 1A	0.15	0.25	0.12	0.0263	14
Area 2A	0.09	0.34	0.17	0.0045	20
Area 3A	0.19	0.54	0.27	0.0028	34

	10-MINUTE UNIT HYDROGRAPH				
	t_{pr} (MINUTES)	$640C_p$	Q_{pr} (cfs)	W-75 (MINUTES)	W-50 (MINUTES)
Area 1A	8.5	410	435	7	12
Area 2A	12	410	185	11	17
Area 3A	20	410	235	18	28

TERMINOLOGY

SLOPE: Slope of the longest watercourse.

T_c: Time of concentration, i.e., the time of travel of rainfall runoff from the most distant part of the watershed to the outflow point.

Other terms are defined in Table A-1.

7. Unit Hydrographs for Future Conditions. To determine the impact of urbanizaton on peak discharges (see Main Report for Future Land Use Map), unit hydrographs and rainfall runoff hyetographs were first developed for the existing condition and then modified to reflect the future condition. The unit hydrographs for the existing condition are identical to the non-increased unit hydrographs developed for the SPF and are shown on Plate A-5. The non-increased unit hydrographs were used for all flood frequencies to provide a uniform basis of comparison. And since the drainage areas are small, the unit hydrographs for the minor and major floods are not expected to vary considerably. The increased peak for the SPF unit hydrograph was a conservative estimate. For the future condition, the lag times of the unit hydrographs were recomputed and determined by the relationship, Lag = 0.6 X Time of Concentration, where the Time of Concentration represents the time of travel of rainfall runoff from the most distant part of the watershed to the outflow point. The Time of Concentration was determined from the Soil Conservation Service publication entitled, "Urban Hydrology for Small Watersheds," January 1975. The unit hydrographs for the future condition were constructed based on the changes made to the lag time and are shown on Plate A-6.

8. Rainfall. The Probable Maximum Precipitation (PMP) for Garapan was also obtained from the Ugum River report. Subsequent review of the report by the Office of the Chief of Engineers recommended that a PMP of 48 inches for a 24-hour period be used for the Ugum River watershed. In accordance with the recommendation, a 24-hour PMP rainfall of 48 inches was selected for the Garapan watershed. The depth-duration curve and depth-area curve for the PMP are shown on Plates A-7 and A-8, respectively.

9. Since the Standard Project Storm (SPS) rainfall has not been established for either Saipan or Guam, the SPS was assumed to be 50 percent of the PMP. The assumption is within the guidelines of EM 1110-2-1411 and is somewhat justified by past rainfall data on Guam. Super Typhoon Pamela (21 May 1976) produced Guam's highest recorded 24-hour rainfall of 27 inches at the NWS Taguac site. Prior to "Pamela," the highest 24-hour recorded rainfall of 24.5 inches occurred at the Agana Agricultural Experimental Station during the 1 October 1924 typhoon. Although SPS determinations are made using various meteorological factors, the primary governing factor is the highest recorded rainfall (except for very unusual events). A detailed investigation for the SPS rainfall is beyond the scope of this study, but nevertheless, the assumption of a 24-hour SPS rainfall of 24 inches (50 percent of PMP) for the Garapan watershed is deemed reasonable.

10. Rainfall intensity-duration-frequency curves for Guam or Saipan have not been previously developed. Consequently, storm hyetographs, arranged to produce maximum discharges, were derived using available information. For the existing condition, the peak discharges for various flood frequencies were determined by the regression-correlation analysis and the unit hydrographs for the drainage areas were derived in the SPF analyses. The relationship between the two knowns - peak discharge and unit hydrographs - were analyzed to produce the storm hyetographs. The storm hyetographs were determined by a

trial and error method which applied various proportions of the SPS hyetograph to the unit hydrograph to match the peak discharges of the regression-correlation equations. Although the computed hyetograph is theoretical in its derivaton, it does compare favorably with the intensity-duration-frequency curves for the Hawaiian Islands. The computed hyetographs for the 2-year and 100-year floods are illustrated on Plates A-9 and A-10, respectively, and are divided into two categories - Rainfall Losses and Rainfall Excesses.

11. Infiltration Losses. Infiltration losses were assumed to be uniform and were estimated by the Soil Conservation Service method of relating soil types and land use to curve numbers from which rainfall losses can be determined. From an estimation of the soil types of the Garapan watershed, an infiltration loss rate of 0.6 inches per hour for the SPS was used.

12. For the future condition in the watershed (see main Report for Future Land Use Map), the SPF was calculated using a reduced infiltration loss rate due to the increased imperviousness associated with development. A loss rate of 0.4 inches per hour was used.

13. Local Drainage. Due to the dissimilar topography, the low flat areas of Garapan (areas 1A, 2A and 3A) were analyzed differently than the upstream areas. Peak discharges for the various flood frequencies and the SPF were determined by the use of unit hydrographs and storm hyetographs. Unit hydrographs were derived by calculating the time of concentration and using the following relationship; Lag = 0.6 x Time of Concentration. Other Snyder's Unit Hydrograph Parameters were assumed to equal those used for the upstream watersheds. The storm hyetographs were assumed to equal those derived in the analysis of the upstream watersheds; changes were made to the rainfall loss rates. The unit hydrographs for Areas 2A and 3A are shown on Plate A-3. Table A-2 summarizes the local drainage characteristics.

14. Flood Routing. Flood hydrographs were routed by the Modified Puls Method using HEC-1. The outflow-discharge relationship was derived using the HEC-2 computer program. The number of routing steps equaled the travel time of the flood wave divided by the routing time step. Routing time steps were made equal to the flood hydrograph time interval of 10 minutes. The travel time of the flood wave was determined by the flood wave celerity method described in EM 1110-2-1408, "Routing of Floods Through River Channels." The ratio of the wave celerity to the mean velocity (Vw/V) of 1.67 (for a wide rectangular channel) was selected. Mean velocities were obtained from HEC-2 computer runs.

15. Standard Project Flood (SPF). The SPF was developed in accordance with the directions and criteria contained in EM 1110-2-1411. Derivation of the SPF was made by applying the unit hydrographs (Plate A-2) to the rainfall excesses of the Standard Project Storm (SPS). The rainfall intensity patterns were structured to produce the maximum runoff for the SPF. The SPF hydrographs for the Garapan watershed are shown on Plate A-11.

16. Peak discharges for the various flood frequencies and the SPF at the shoreline were determined by routing the flood hydrographs of the upstream areas (Areas 1, 2 and 3) and combining the routed flood hydrographs with the local drainage flood hydrographs. Plates A-12 through A-17 show the combined hydrographs at the shoreline. SPF and peak discharges for the subbasins and various concentration points are shown on Table A-3.

DISCHARGE - FREQUENCY ANALYSIS

17. Streamgage Data. Discharge-frequency curves were developed by analyzing maximum annual peak discharge streamgage data obtained from U.S. Geological Survey (USGS) publications and employing the Log - Pearson Type III criteria described in the U.S. Water Resources Council's Manual, "Guidelines for Determining Flood Flow Frequency, "Bulletin 17A. In accordance with the guidelines of Bulletin 17A, only streamgages with 10 or more years of record were used in the analysis. Nine Guam streamgages and two Saipan streamgages, a total of 11 gages having an average of 20 years of record, were examined. Plates A-18 and A-19 show the streamgage locations. Peak discharges were analyzed by using the "Flood Flow Frequency Analysis" computer program developed by HEC. A summary of the frequency analysis and a brief description of the streamgages are shown on Table A-4.

18. Regression-Correlation Analysis. A regression-correlation investigation, relating known hydrologic characteristics of the gaged watersheds in Guam and Saipan to the calculated peak discharge of various frequencies, was made to develop regional peak discharge equations. The data were analyzed by using the "Multiple Regression" computer program developed by HEC. The selected equations relate peak discharges to drainage area sizes and are listed below:

$$Q - 2 \text{ year} = 635 \times DA^{0.948}$$

$$Q - 10 \text{ year} = 1265 \times DA^{0.933}$$

$$Q - 50 \text{ year} = 1915 \times DA^{0.924}$$

$$Q - 100 \text{ year} = 2215 \times DA^{0.922}$$

$$Q - 500 \text{ year} = 2975 \times DA^{0.915}$$

Where Q is in CFS and DA in square miles. The unadjusted determination coefficients (R^2) for the 2, 10, 50, 100 and 500 year peak discharge equations are 0.828, 0.834, 0.800, 0.782, and 0.737, respectively. The standard error in Log for the 2, 10, 50, 100 and 500 year peak discharge equations are: 0.219, 0.212, 0.235, 0.248 and 0.278, respectively.

19. The independent variables used in the analysis but deleted in the final analysis included the mean annual precipitation (AP), slope of the main channel (SL), length of the main channel (CL), mean elevation (EL), forest

TABLE A-3. SUMMARY OF PEAK DISCHARGES

EXISTING CONDITION - (NO PROJECT) AT WEST COAST HIGHWAY

Flood	Peak Discharges (cfs) Area 1	Area 2	Area 3
2-year	510	190	330
10-year	1,160	390	670
50-year	2,000	660	1,120
100-year	2,400	820	1,400
500-year	3,800	1,400	2,400
SPF	3,800	1,700	2,900

EXISTING CONDITION - (NO PROJECT) AT THE SHORELINE

Flood	Peak Discharges (cfs)** Area 1 & 1A	Area 2 & 2A	Area 3 & 3A
2-year	400	150	200
10-year	1,100	380	640
50-year	2,150	720	1,300
100-year	2,800	940	1,700
500-year	5,000	1,600	3,100
SPF	5,100	1,650	3,100

FUTURE PROJECT CONDITION AT WEST COAST HIGHWAY

Flood	Peak Discharges (cfs) Area 1*	Area 2	Area 3	Area 2&3***
2-year	510	250	410	640
10-year	1,160	470	760	1,150
50-year	2,000	760	1,250	1,800
100-year	2,400	920	1,550	2,250
500-year	3,800	1,500	2,600	3,750
SPF	3,800	1,750	3,000	4,600

*Developments are not planned for Area 1.
**Combined and routed discharges at the shoreline.
***Discharges used for Plan 1.

LOCAL DRAINAGE - EXISTING CONDITION

Flood	Peak Discharges (cfs) Area 1A	Area 2A	Area 3A
2-year	120	65	115
10-year	320	180	320
50-year	600	340	620
100-year	750	440	800
500-year	1,250	760	1,350
SPF	1,000	560	1,050

COMBINED DISCHARGE (FUTURE CONDITION) - NO PROJECT

Flood	Peak Discharges (cfs) Area 1 & 1A	Area 2 and 2A	Area 3 & 3A
2-year	450	190	240
10-year	1,150	460	720
50-year	2,200	830	1,450
100-year	2,850	1,050	1,900
500-year	5,000	1,700	3,400
SPF	5,100	1,700	3,200

TABLE A-4

STREAMGAGES ON GUAM AND SAIPAN

STATION NUMBER	STATION NAME	LENGTH OF RECORD (Years)	DRAINAGE AREA (Sq. Miles)	Q2	PEAK DISCHARGE (cfs) Q10	Q100	MAXIMUM OF RECORD
8083	Finile Creek at Agat	17	0.28	215	328	464	326
8160	Umatac River at Umatac	23	2.11	2,480	5,200	9,520	7,460
8210	Geus River near Merizo	22	0.93	729	2,060	4,780	2,940
8400	Tinaga River near Inarajan	25	1.89	795	2,020	4,330	2,980
8470	Imong River Near Agat	17	1.95	1,950	2,870	3,940	3,370
8480	Almagosa Springs near Agat	19	0.70	203	442	832	770
8550	Ugum River Near Talofofo	19	7.13	2,650	6,350	13,000	7,660
8580	Ylig River near Yona	24	6.48	3,090	4,630	6,430	4,900
8650	Pago River near Ordot	25	5.67	4,230	7,020	10,600	10,090
8010	South Fork Talofofo Stream (Saipan)	10	0.69	720	2,450	6,660	3,460
8015	Middle Fork Talofofo Stream (Saipan)	11	0.35	214	620	1,480	840

cover (FC), shape factor (SF), and 1-hour rainfall for the 10, 50, and 100 year storm event (RF). The linear regression equation used in the investigation was of the following form:

$$Q = Cp\ DA^{a}\ AP^{b}\ CL^{c}\ SL^{d}\ EL^{e}\ FC^{f}\ SF^{g}\ RF^{h}$$

It was ultimately reduced to the selected equations which reflected the best combination of correlation, application, and conformance to hydrologic principles.

20. Discharge-Frequency Curves. From the equations selected in the regression-correlation analysis, the peak discharges were computed for various frequencies and then plotted on probability paper. The best fit line of the computed discharges was adjusted to the expected probability curve. The adjustment was made by using N = 20 (the average number of years of record for the streamgages used in the regression-correlation study) in the P_n versus P Table shown in "Statistical Methods in Hydrology", Leo R. Beard, January 1962. Plate A-20 shows the discharge-frequency curves at the West Coast Highway.

21. Peak discharges for the future condition were determined by applying the computed hyetographs, modified by lesser infiltration rates to reflect increased imperviousness, to the unit hydrographs developed for the Future Condition. A 33% increase in imperviousness was used and was based on the area planned for future development and the anticipated impervious factors of the future development. Plates A-21 and A-22 depict the 2-year and 100-year floods, respectively. The peak discharges of the flood hydrographs were used to develop the discharge-frequency curves which were drawn to the expected probability curve by adjusting the exceedance frequency plotting positions. The adjustment was made using N = 20 (the average number of years of record for the stream gages used in the regression-correlation analysis) in the Pn versus Poo Table shown in "Statistical Methods in Hydrology." Plate A-23 shows the discharge-frequency curves for the future condition.

22. Discharge-Frequency Curves at Shoreline. The discharge-frequency curves were developed by the same procedures described in previous paragraphs. The discharge-frequency curves at the shoreline are shown on Plates A-24 and A-25.

FLOODPLAIN ANALYSIS

23. General. The probable overflow area is defined as that area most susceptible to overflow based on the areas inundated by historical flood events and existing conditions. Probable overflow limits for the 100-year and standard project flood and the limits of possible overflow were prepared for use in the economic determination of flood damages caused by each return period flood. These limits are delineated for purposes of evaluating potential flood damages for benefit analysis and constitute no assurance that shifting debris would not cause overflow to move to other locations within the gross area subject to inundation.

24. Flood Limits. Flood elevations associated with the peak discharges were determined by the HEC-2 computer program. Manning's Roughness Coefficient, n, of 0.04 to 0.08 was used for overland flow. Garapan is subject to shallow flooding with flood flows in the subcritical flow regime. Velocities are low, ranging from 1 to 4 feet per second for the 100-year flood. Due to the flat topography of the Garapan area, the flood discharges will cause flood limits of irregular boundaries intermixed with adjacent flood plains. The flood limits for various floods are shown in the Main Report (Figure 6).

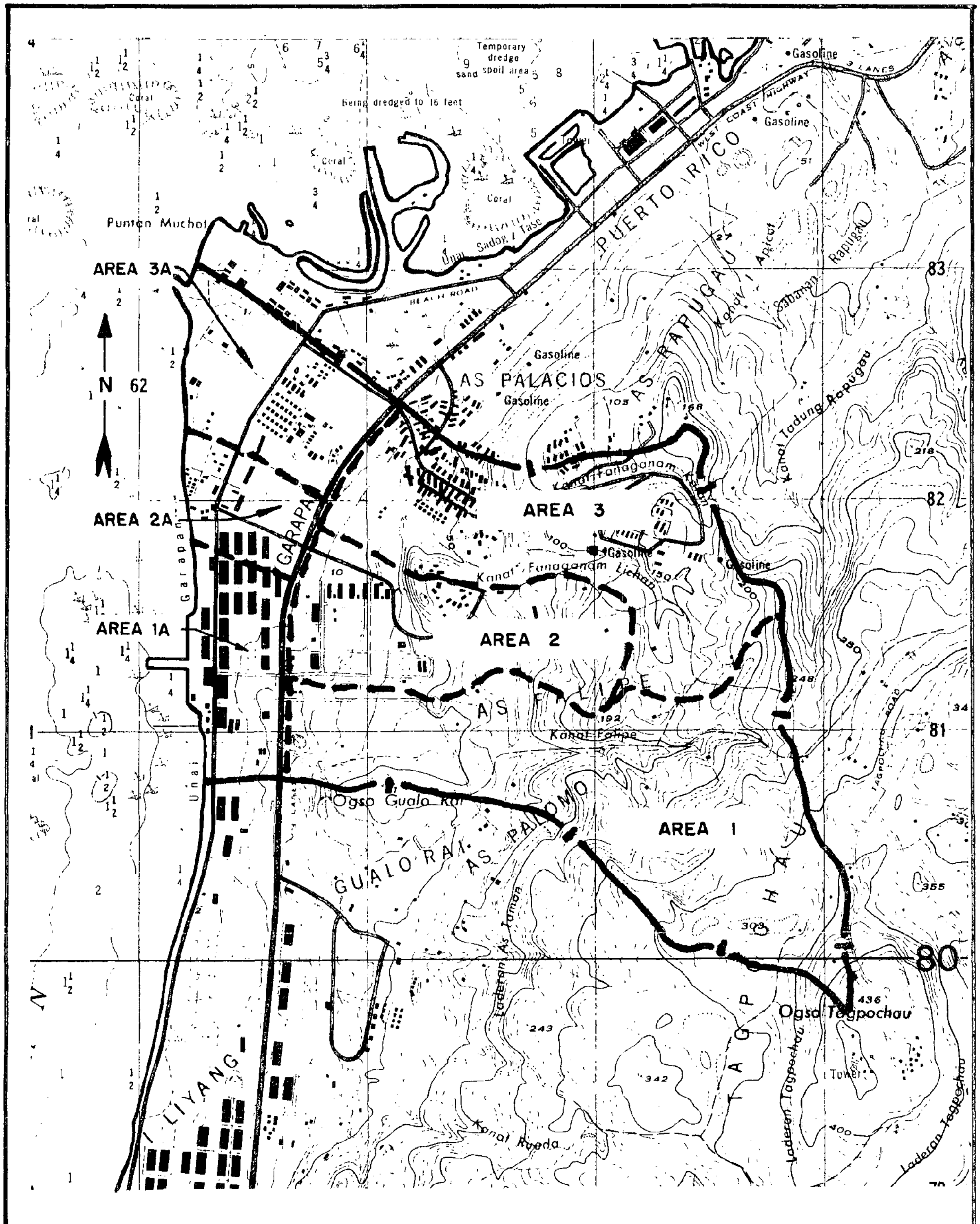
VERIFICATION OF HYDROLOGIC INVESTIGATION

25. A study to substantiate the computed results of the hydrologic investigation with observed data is impossible due to the absence of flood data for the Garapan watersheds. The only reliable known flood data for the area are the high water marks surveyed by the USGS for the 8-12 August 1978 flood. Compared against flood elevations computed by the HEC-2 computer program using peak discharges derived in the hydrologic investigation, the 1978 flood was estimated to range between a 10-year and a 30-year flood. The range of flood frequencies is not very significant since the flood elevations of the 10-year and 30-year floods vary by an average of only 0.25 to 0.3 foot. Perhaps the primary reason that the 1978 flood cannot be exactly matched with a flood frequency is the inability of the HEC-2 computer program to accurately model the subtleties of overland flow where local obstructions, dividing flows, intermixing flows, actual flood hydrograph, and splash waves add to its complexity. The surveyed high water marks attest to the irregular nature of overland flow in the Garapan area. In one instance, a difference of 0.4 feet between high water mark elevations was measured in a residential lot. In another, the upstream high water mark elevation was slightly lower than a downstream mark. Surveying errors are very possible and would further distort comparisons between actual and computed flood surface elevations. The 1978 flood was remembered as the most severe flood encountered in the Garapan area by many long-time residents, an account which favors a 30-year flood classification for the 1978 flood. Other flood data such as rainfall intensities, flood stages and peak discharges for the Garapan watershed are not known to exist. Thus, the results of this investigation are without verification due to the absence of data.

LOCAL DRAINAGE - WITH PROJECT CONDITION

26. The exact local drainage discharge contribution, i.e., the discharge and its inflow location, have not been determined for the structural alternative plans discussed in the main report and Appendix C. Local agencies, especially MIHA, have been contacted and made aware of the possible use of the structural alternatives as a means of also serving the local drainage system. Earlier statements from MIHA indicated that they were planning to install an improved drainage system not connected to any of the structural alternative plans. However, it is very likely that should a structural (channel) plan be

approved and constructed, the local agencies will use the channel to carry local drainage discharges. Since, the local drainage system is not a major contributor to the design flows, accommodation for local discharges can easily be made to the structural alternative plans, the local agencies have not shown any desire for including specific local drainage plans and tie-ins to the structural alternative plans, and the local drainage system is the responsibility of the local government, approximate estimations of additional local drainage discharges to the structural alternative plans were made. These estimations were made using the results and general procedures of the detailed hydrologic investigation. After a plan is selected, a detailed hydrologic and hydraulic analyses will be made to accommodate the local drainage system. The drainage system will be coordinated with the local agencies.



GARAPAN FLOOD CONTROL SAIPAN, CNMI

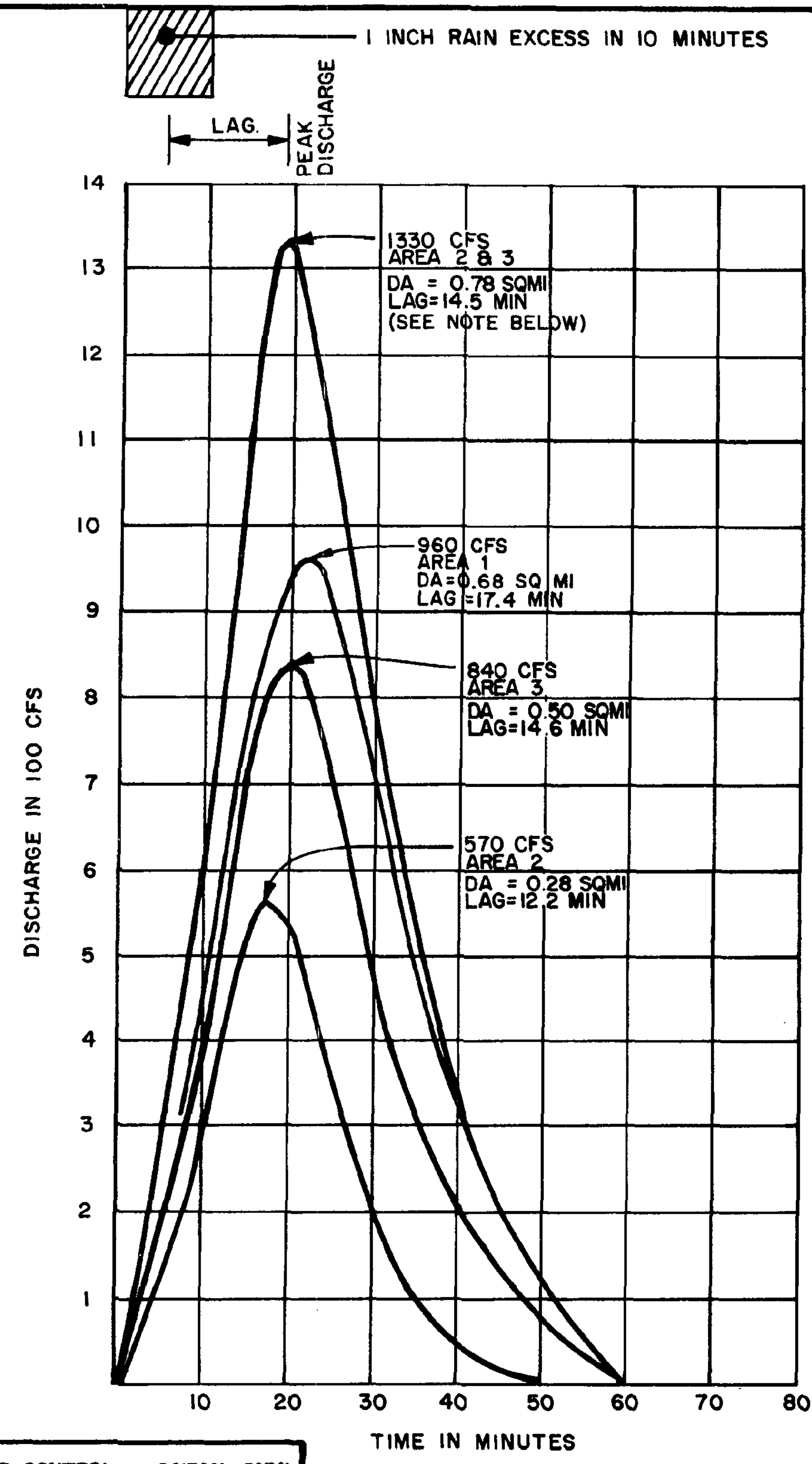
DRAINAGE AREAS

U.S. ARMY ENGINEER DISTRICT, HONOLULU

10 METER CONTOUR INTERVAL
SCALE

0 1/2 1 MILE

PLATE A-1

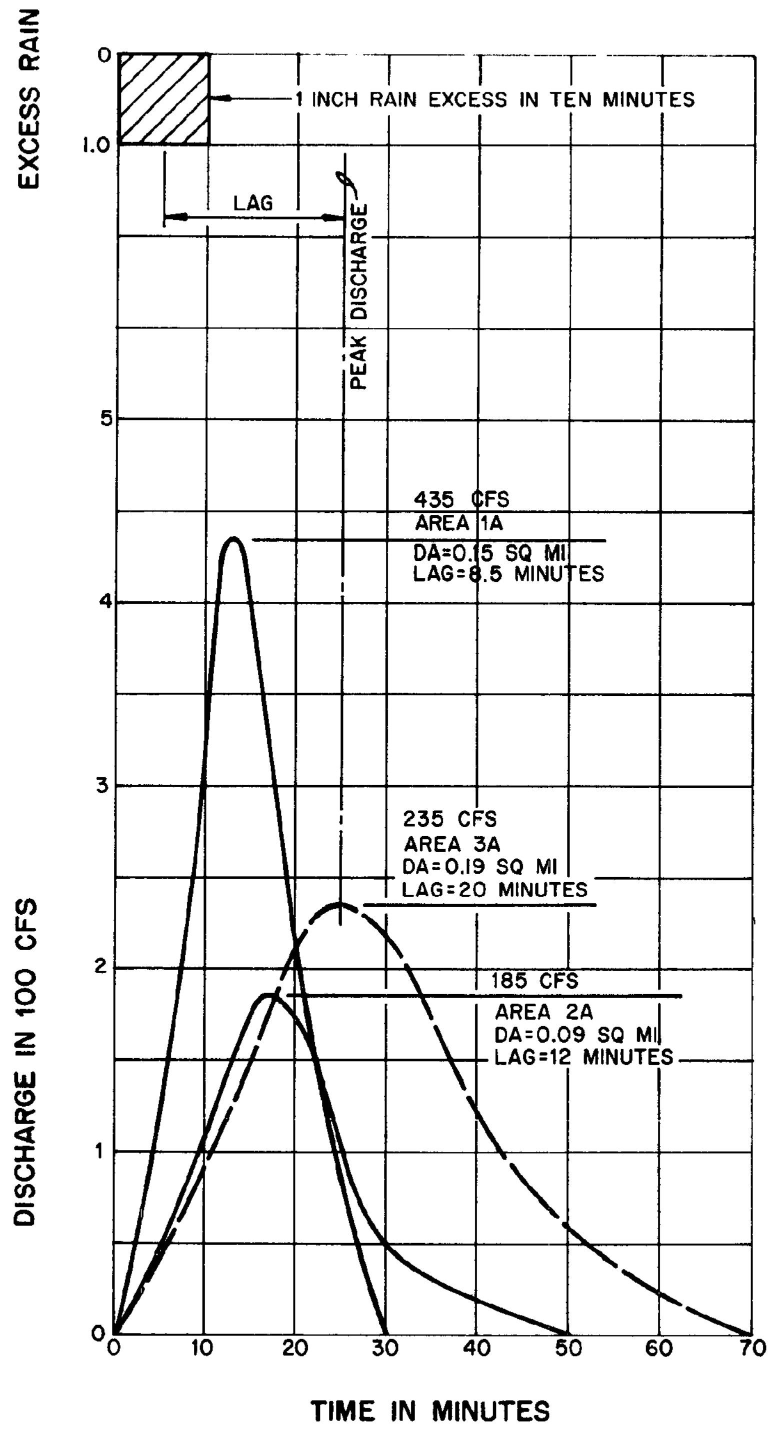


GARAPAN FLOOD CONTROL	SAIPAN, CNMI

10 MINUTE UNIT HYDROGRAPHS
PEAK INCREASED BY 50%
EXISTING CONDITION

U.S. ARMY ENGINEER DISTRICT, HONOLULU

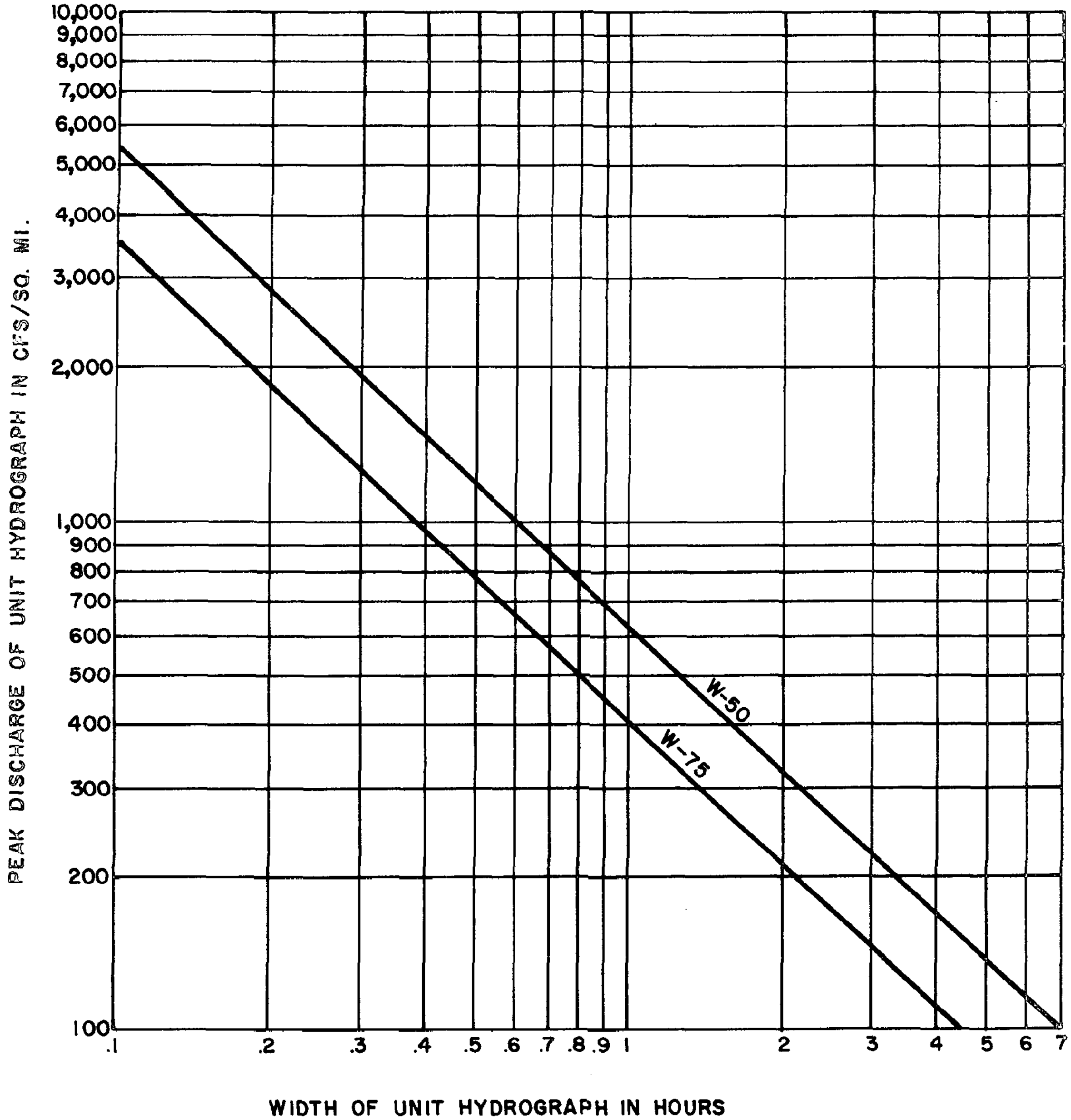
NOTE:
AREA 2 AND 3 IS DEVELOPED FOR PLAN 1 (SEE APPENDIX C) AND REPRESENTS A WITH PROJECT CONDITION.



GARAPAN FLOOD CONTROL SAIPAN, CNMI

LOCAL DRAINAGE
10 MINUTE UNIT HYDROGRAPHS
EXISTING CONDITION

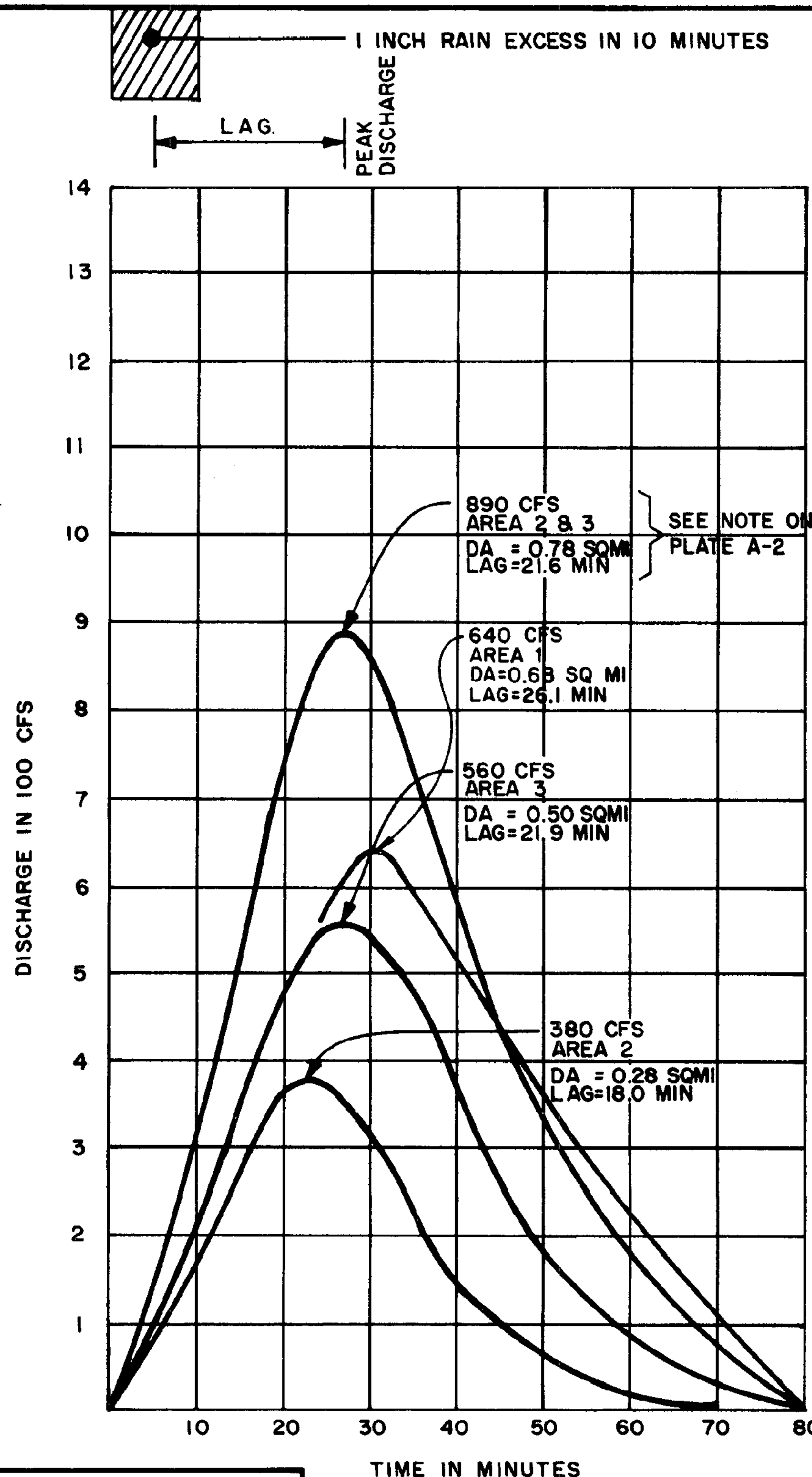
U.S. ARMY ENGINEER DISTRICT, HONOLULU



GARAPAN FLOOD CONTROL SAIPAN, CNMI

UNIT HYDROGRAPH
PEAKS VERSUS WIDTHS

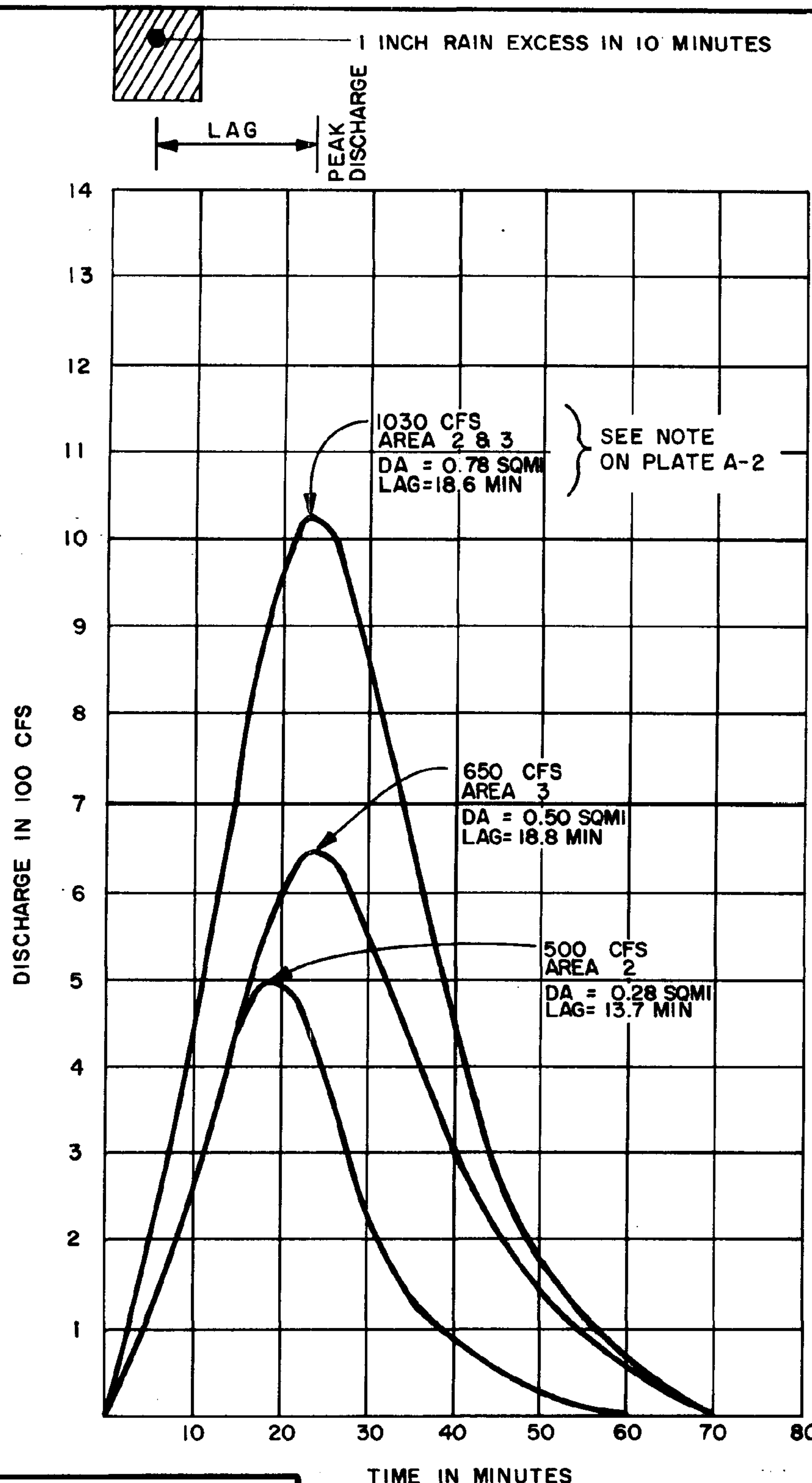
U.S. ARMY ENGINEER DISTRICT, HONOLULU



GARAPAN FLOOD CONTROL SAIPAN, CNMI

NON-INCREASED
10 MINUTE UNIT HYDROGRAPHS
EXISTING CONDITION

U.S. ARMY ENGINEER DISTRICT, HONOLULU

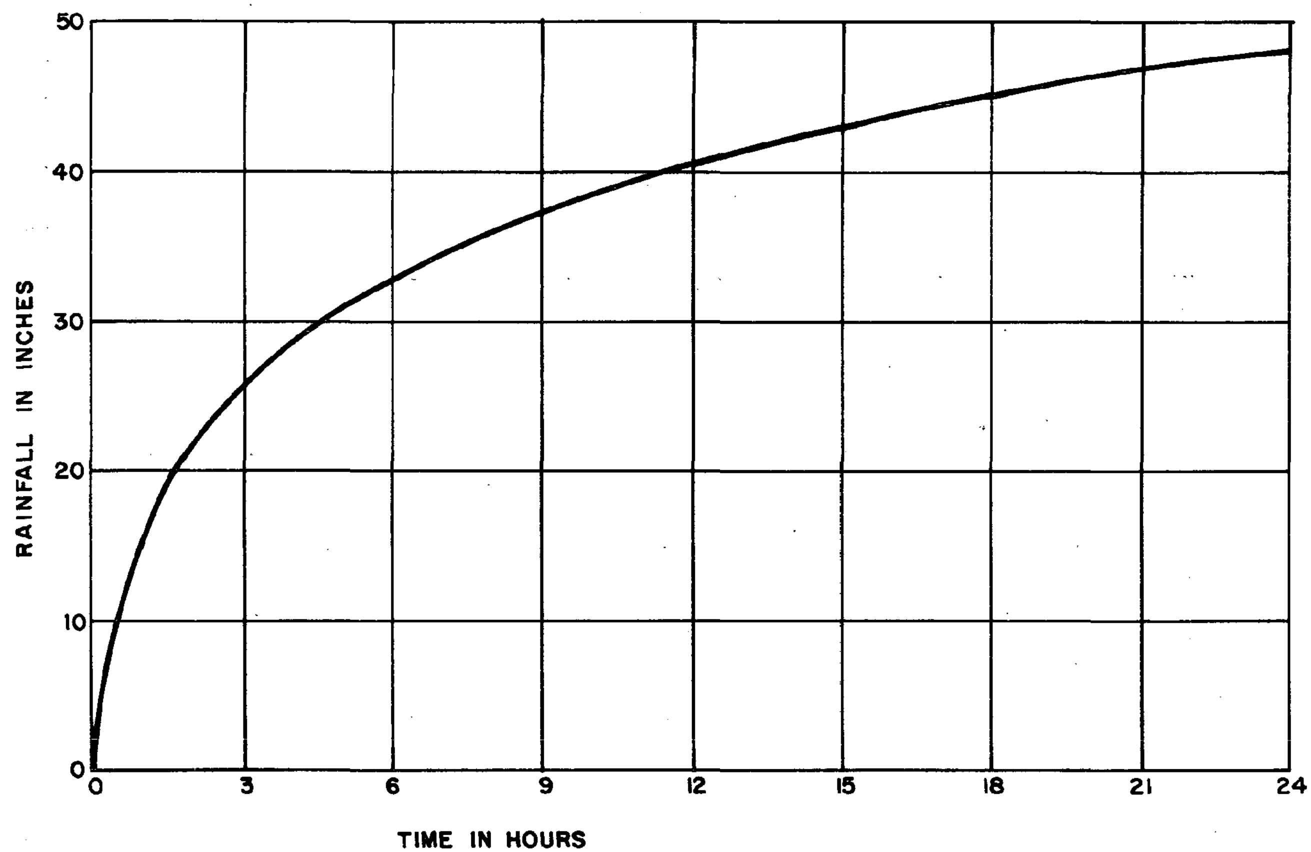


GARAPAN FLOOD CONTROL SAIPAN, CNMI

PEAK INCREASED
10 MINUTE UNIT HYDROGRAPHS
FUTURE CONDITION

U.S. ARMY ENGINEER DISTRICT, HONOLULU

NOTE:
UNIT HYDROGRAPH FOR AREA I IS THE SAME FOR BOTH EXISTING AND FUTURE CONDITIONS SINCE NO DEVELOPMENT IS PLANNED FOR THE AREA.
(SEE PLATE A-5)

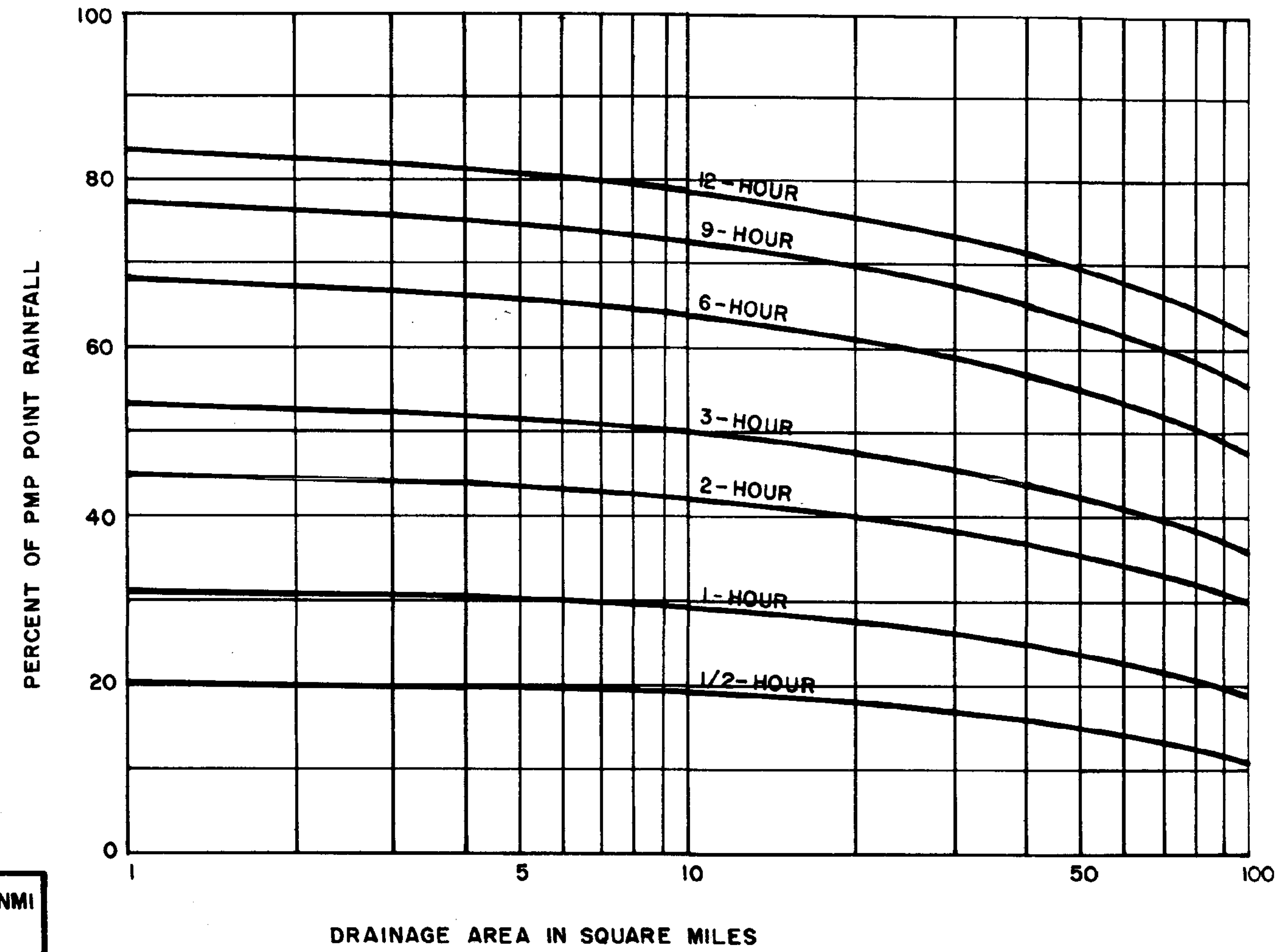


GARAPAN FLOOD CONTROL SAIPAN, CNMI

DEPTH–DURATION CURVE
PROBABLE MAXIMUM PRECIPITATION

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE A-7



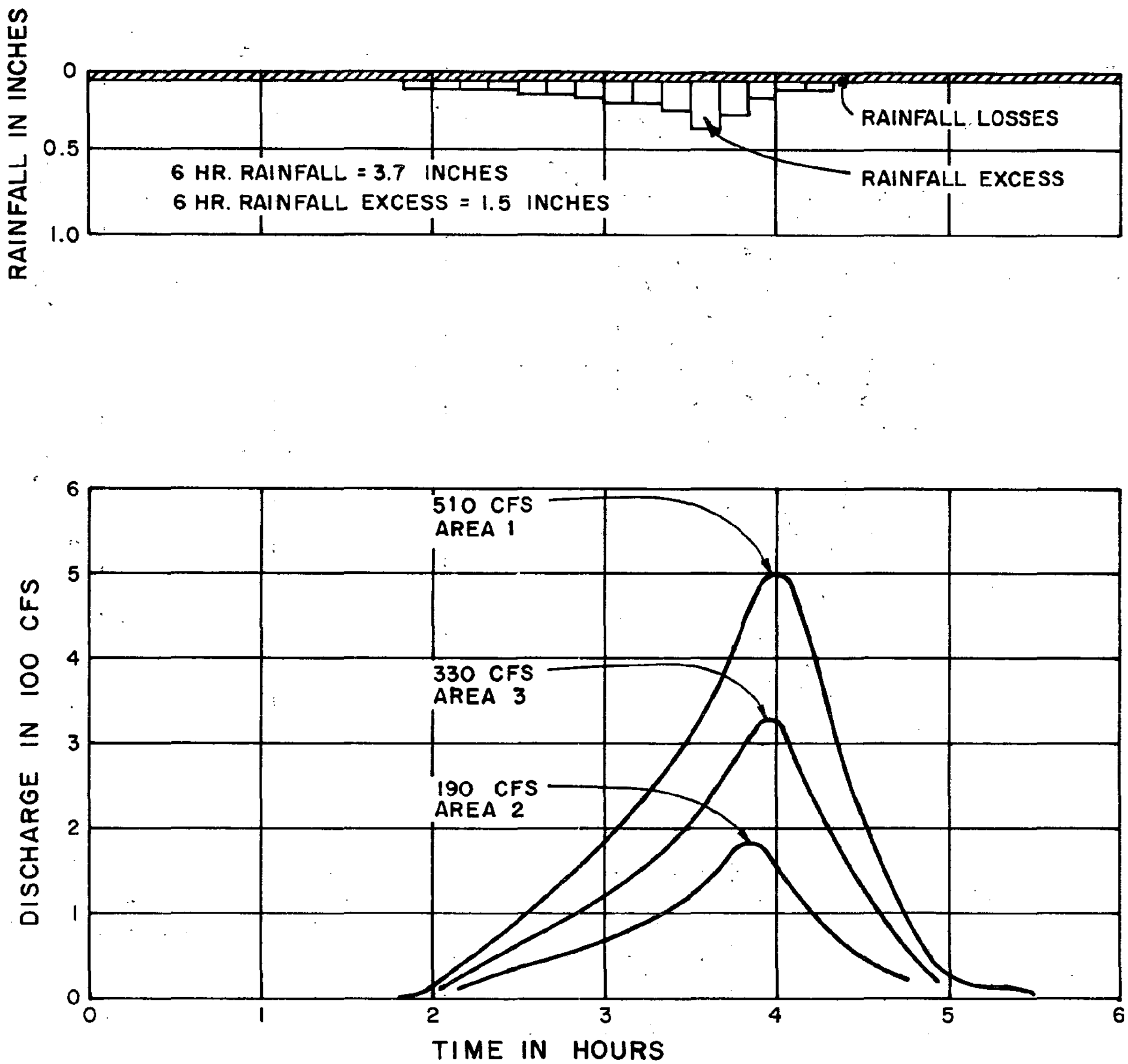
NOTE: 24-HOUR PMP RAINFALL = 48 INCHES

GARAPAN FLOOD CONTROL SAIPAN, CNMI

DEPTH-AREA CURVE
FOR
PROBABLE MAXIMUM
PRECIPITATION

U.S. ARMY ENGINEER DISTRICT, HONOLULU

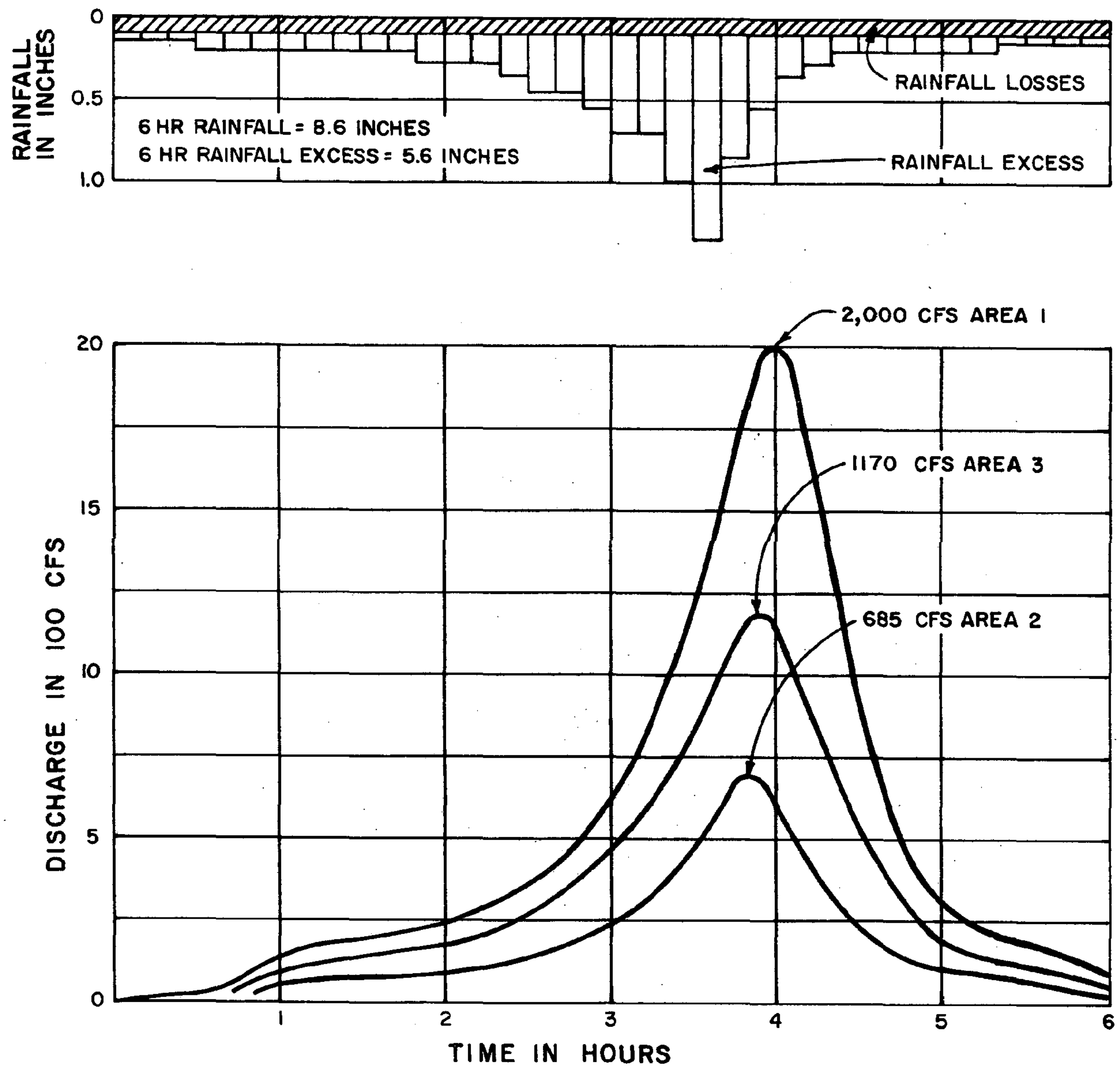
PLATE A-8



GARAPAN FLOOD CONTROL
SAIPAN, CNMI

2-YEAR STORM HYETOGRAPH

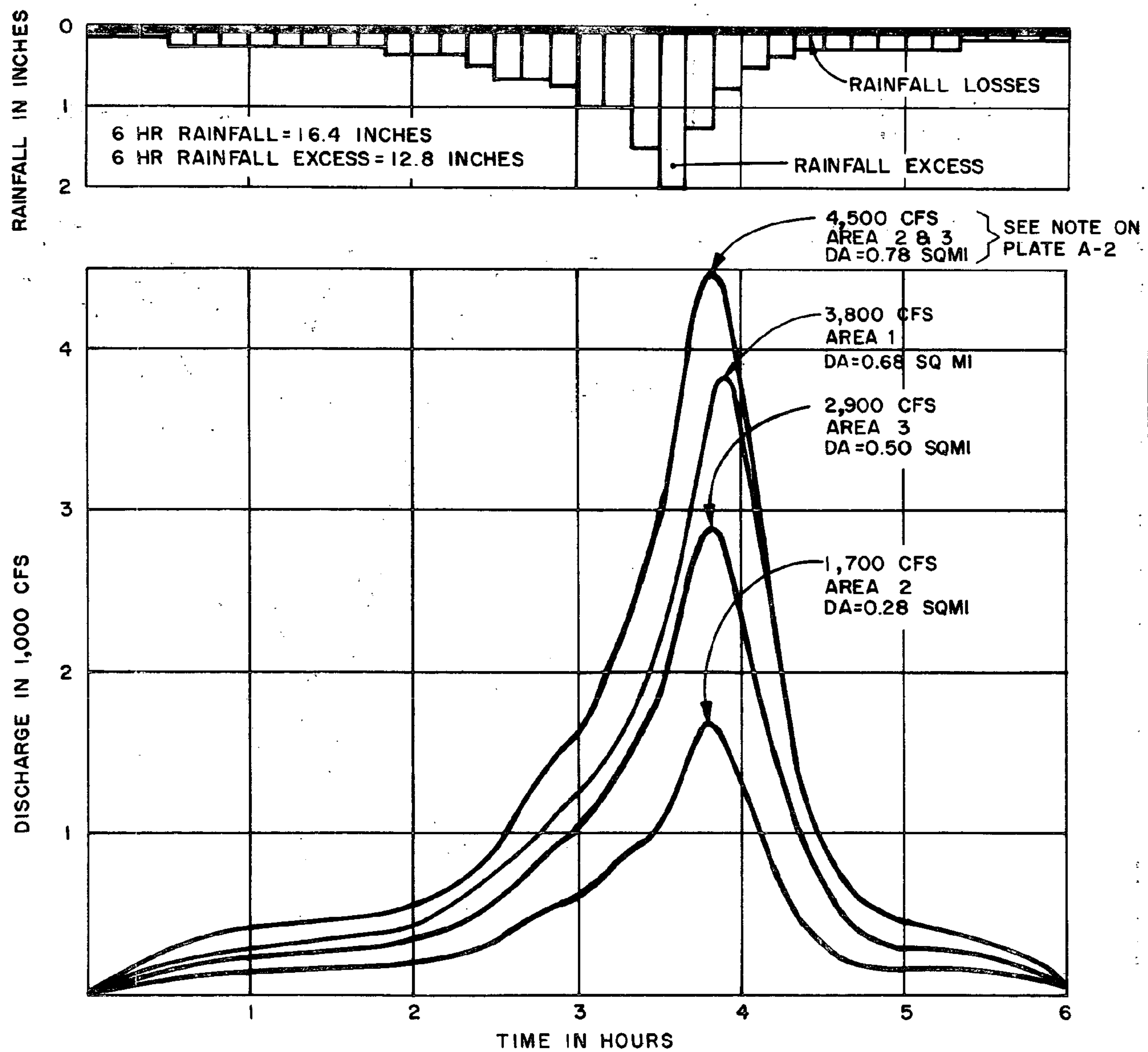
U.S. ARMY ENGINEER DISTRICT, HONOLULU



GARAPAN FLOOD CONTROL
SAIPAN, CNMI

100-YEAR STORM
HYETOGRAPH

U.S. ARMY ENGINEER DISTRICT, HONOLULU

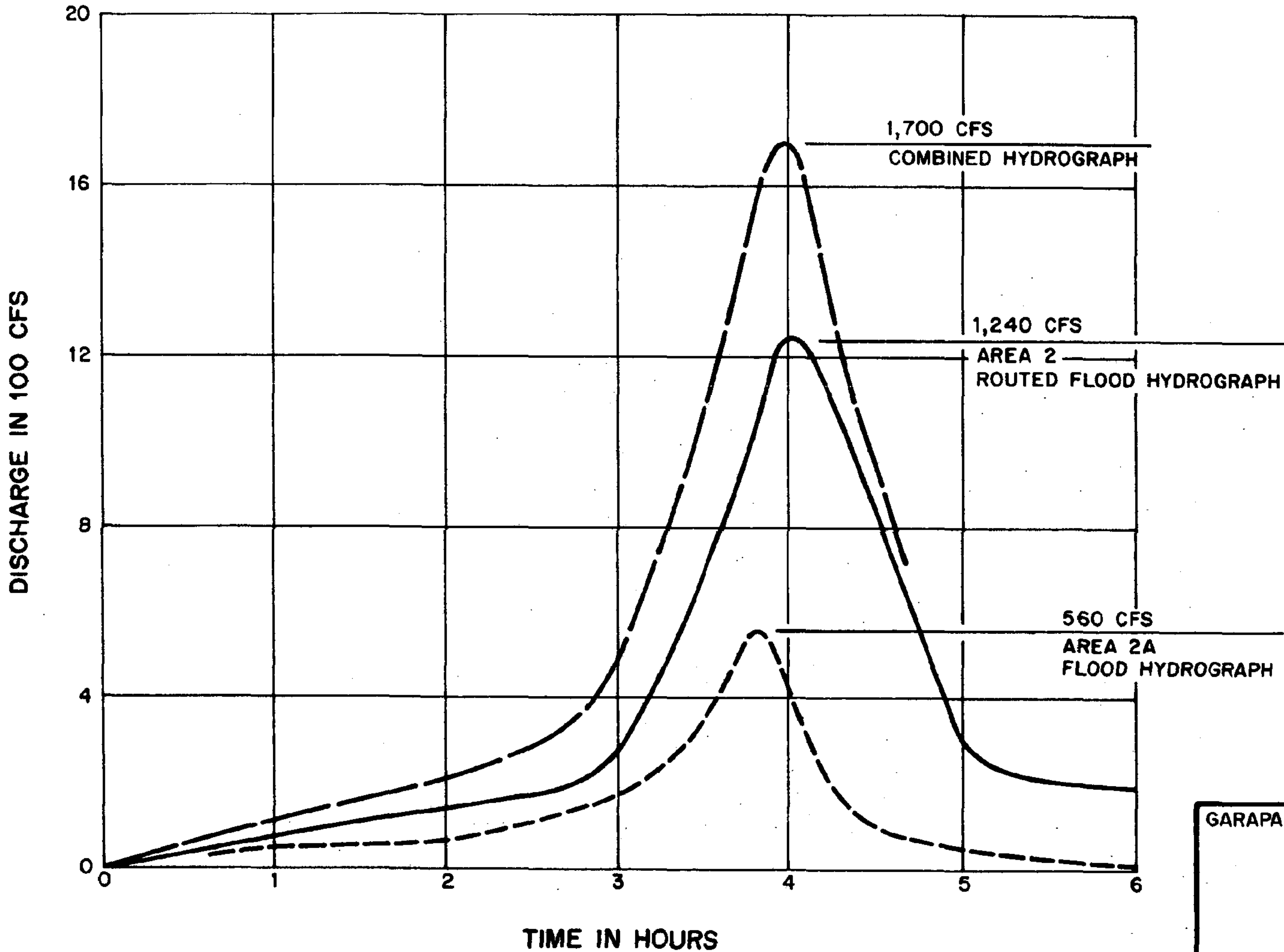


GARAPAN FLOOD CONTROL SAIPAN, CNMI

SPF HYDROGRAPHS
EXISTING CONDITION

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE A-11



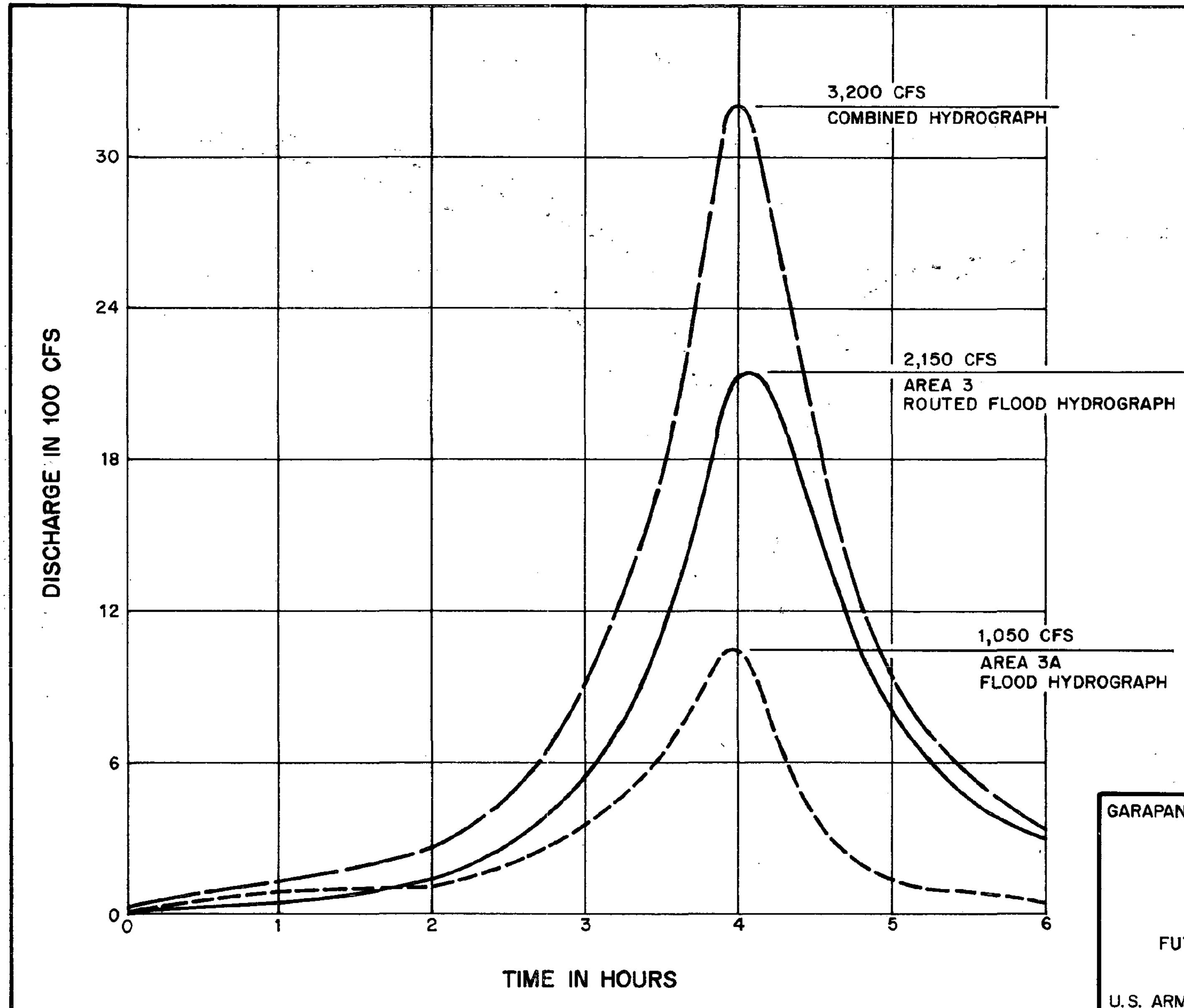
GARAPAN FLOOD CONTROL SAIPAN, CNMI

SPF HYDROGRAPH AT THE SHORELINE

FUTURE CONDITION-NO PROJECT (AREA 2-2A)

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE A-12

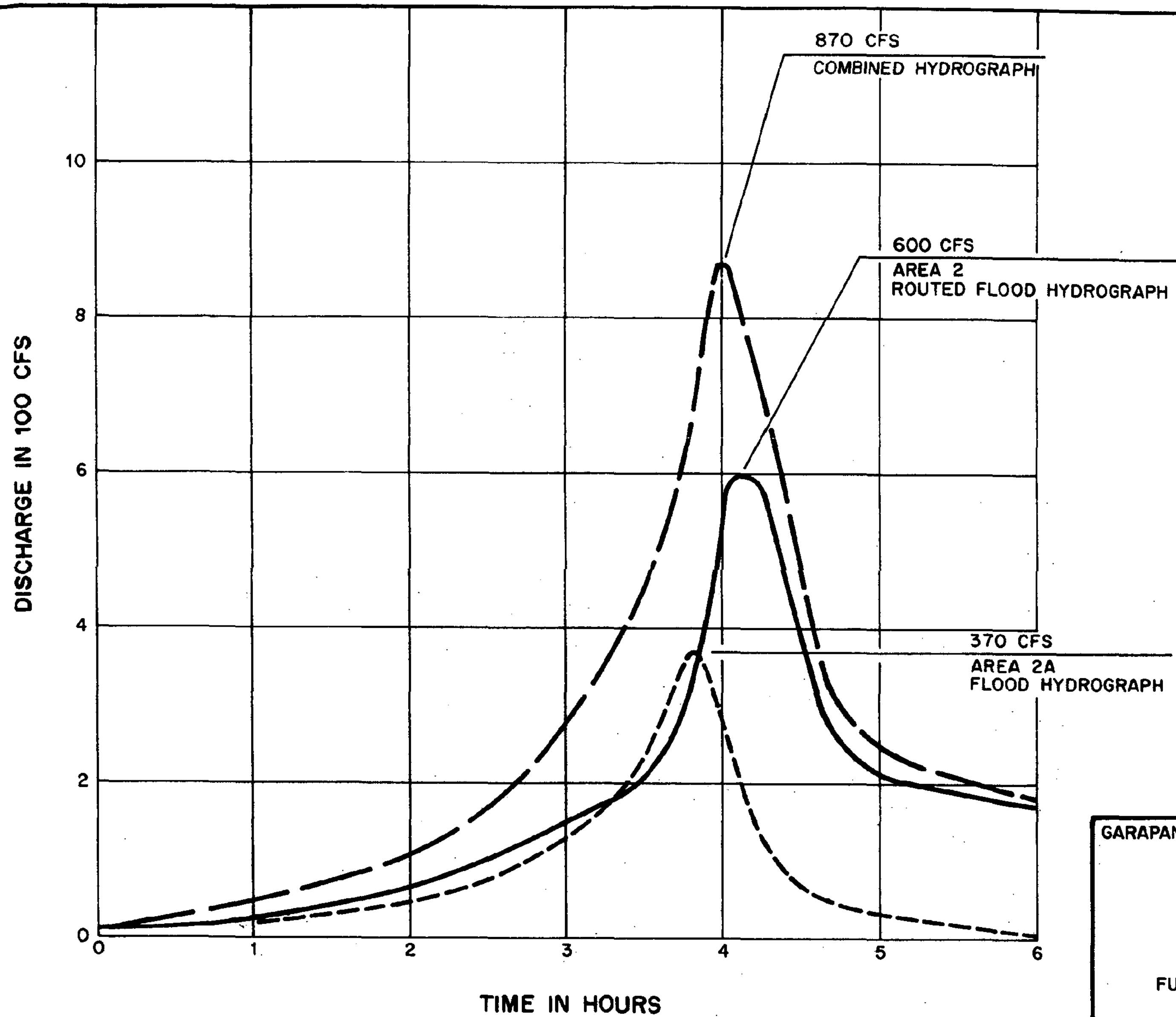


GARAPAN FLOOD CONTROL SAIPAN, CNMI

SPF HYDROGRAPH
AT THE SHORELINE
FUTURE CONDITION-NO PROJECT
(AREA 3-3A)

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE A-13

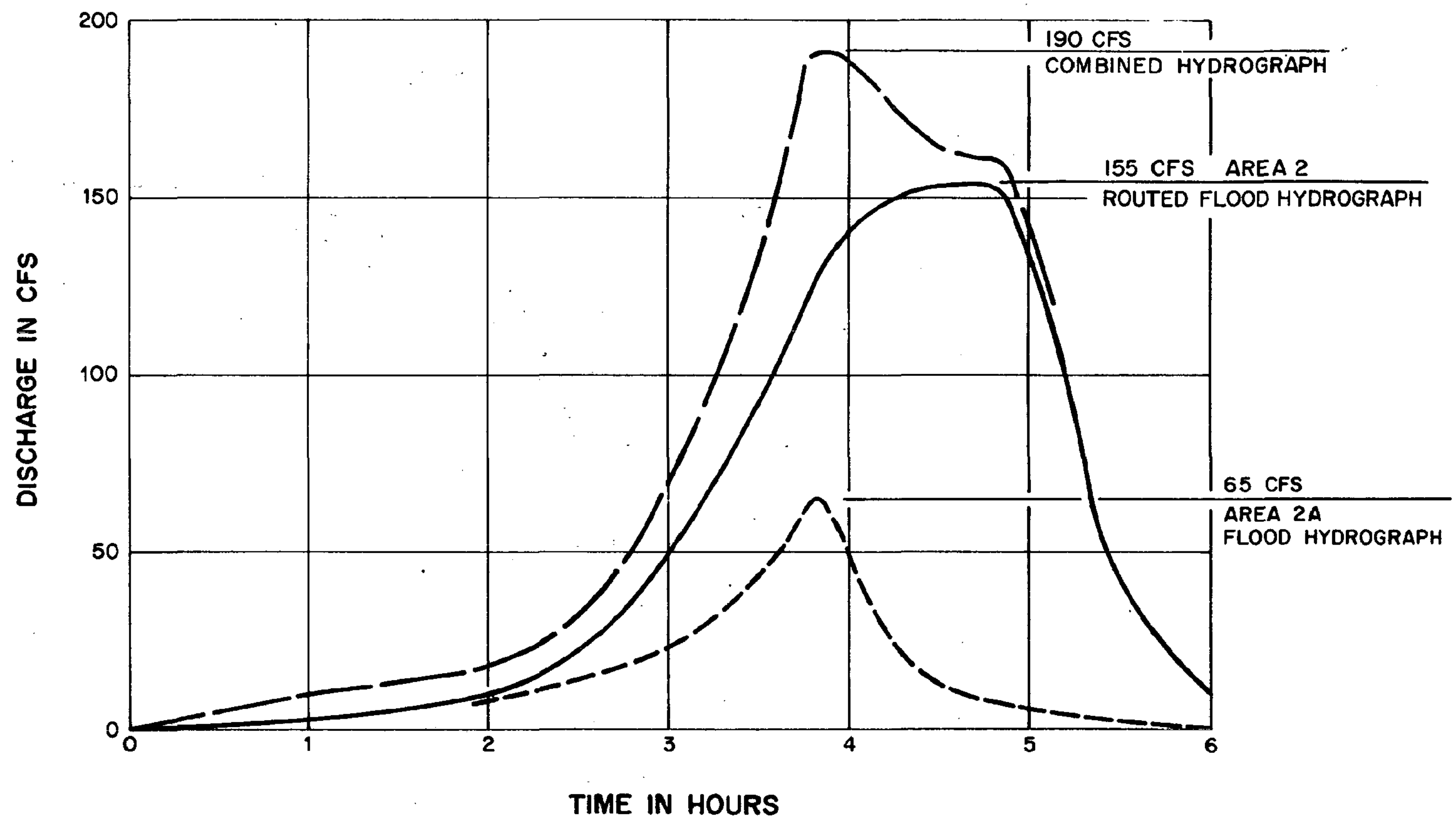


GARAPAN FLOOD CONTROL SAIPAN, CNMI

100-YEAR
FLOOD HYDROGRAPH
AT THE SHORELINE
FUTURE CONDITION-NO PROJECT
(AREA 2-2A)

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE A-14

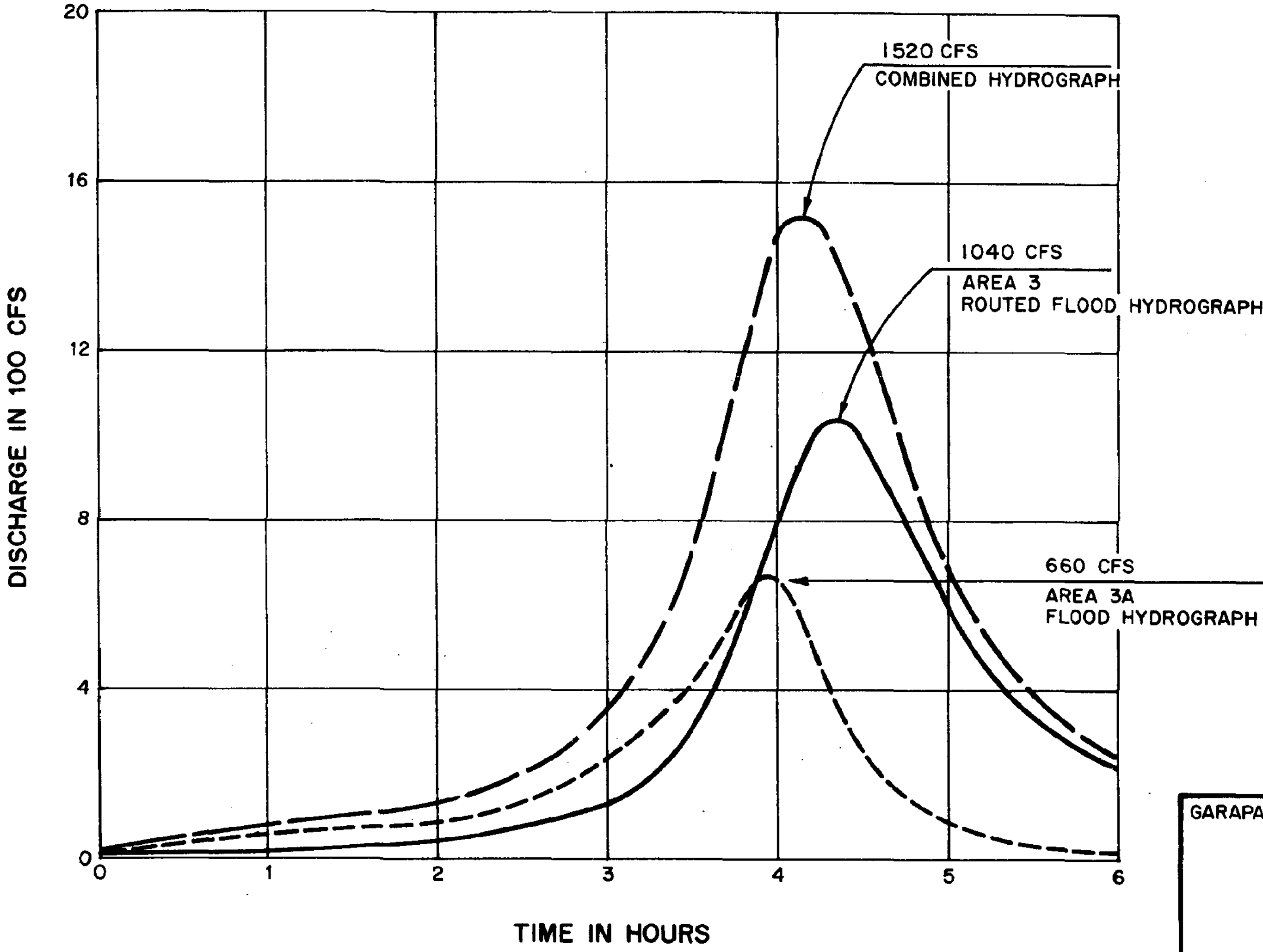


GARAPAN FLOOD CONTROL SAIPAN, CNMI

2-YEAR
FLOOD HYDROGRAPH
AT THE SHORELINE
FUTURE CONDITION-NO PROJECT
(AREA 2-2A)

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE A-15



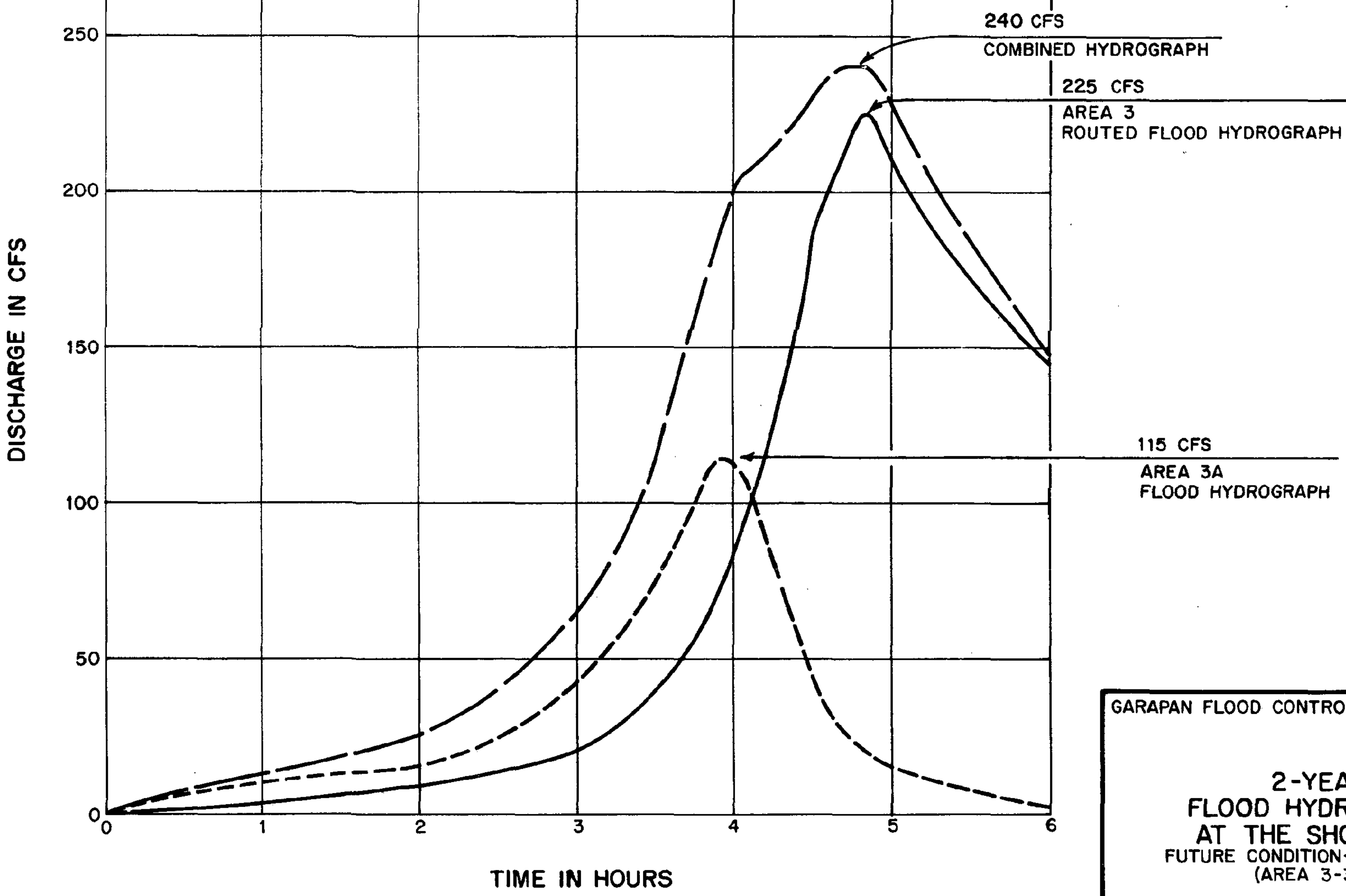
GARAPAN FLOOD CONTROL SAIPAN, CNMI

100-YEAR FLOOD HYDROGRAPH AT THE SHORELINE

FUTURE CONDITION-NO PROJECT (AREA 3-3A)

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE A-16

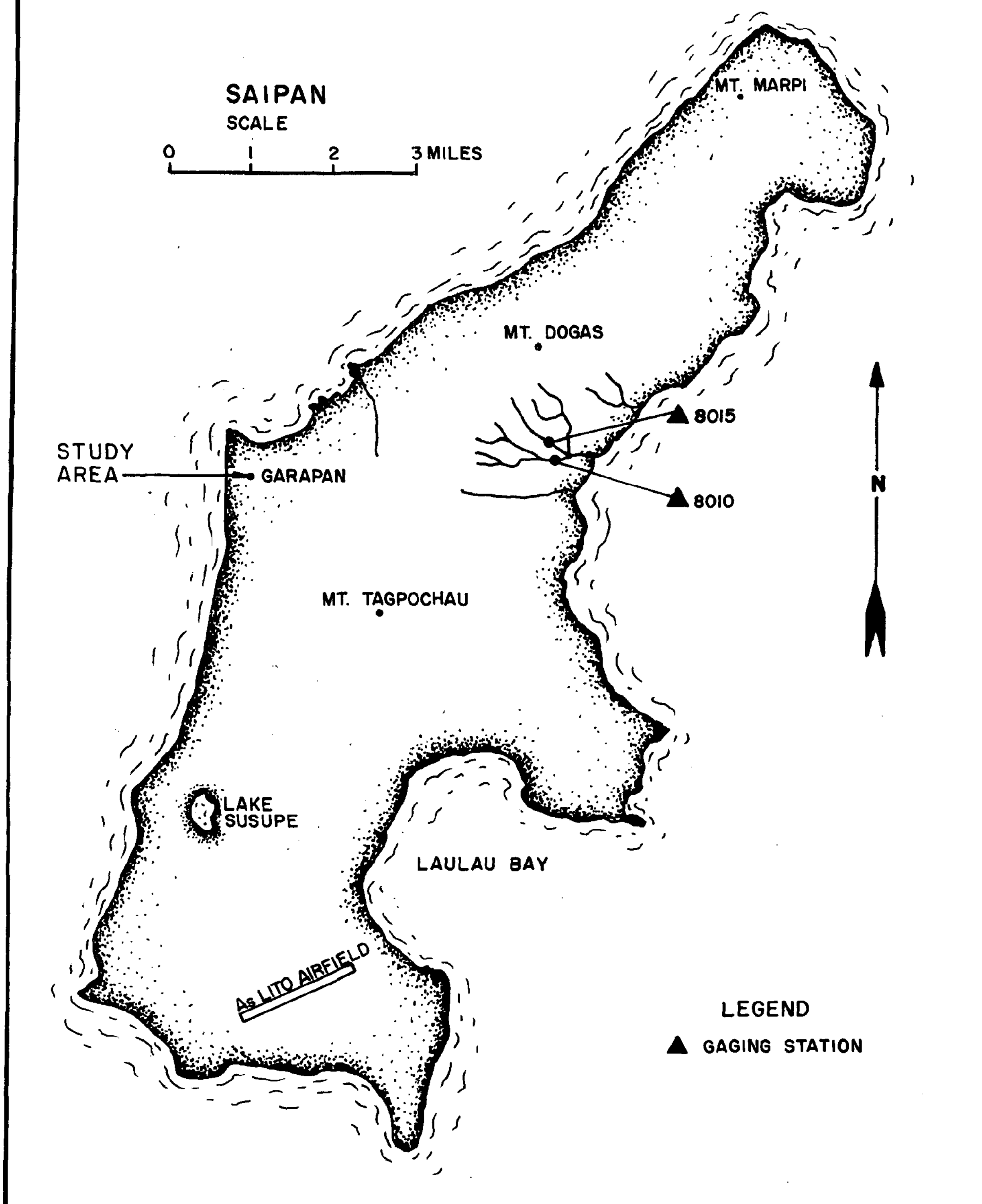


GARAPAN FLOOD CONTROL SAIPAN, CNMI

2-YEAR
FLOOD HYDROGRAPH
AT THE SHORELINE
FUTURE CONDITION-NO PROJECT
(AREA 3-3A)

U.S. ARMY ENGINEER DISTRICT, HONOLULU

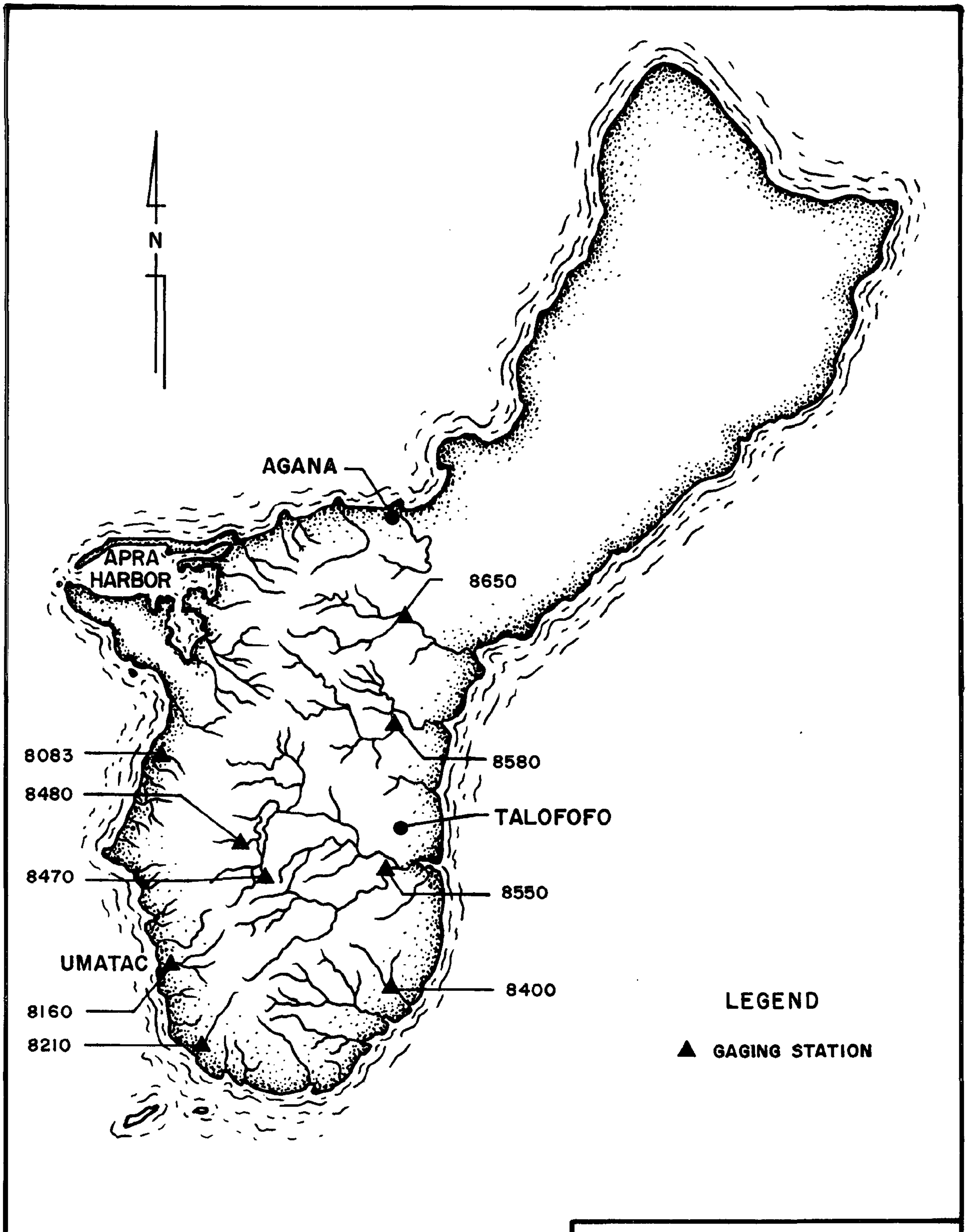
PLATE A-17



GARAPAN FLOOD CONTROL SAIPAN, CNMI

STREAM GAGE AND
STUDY AREA LOCATION

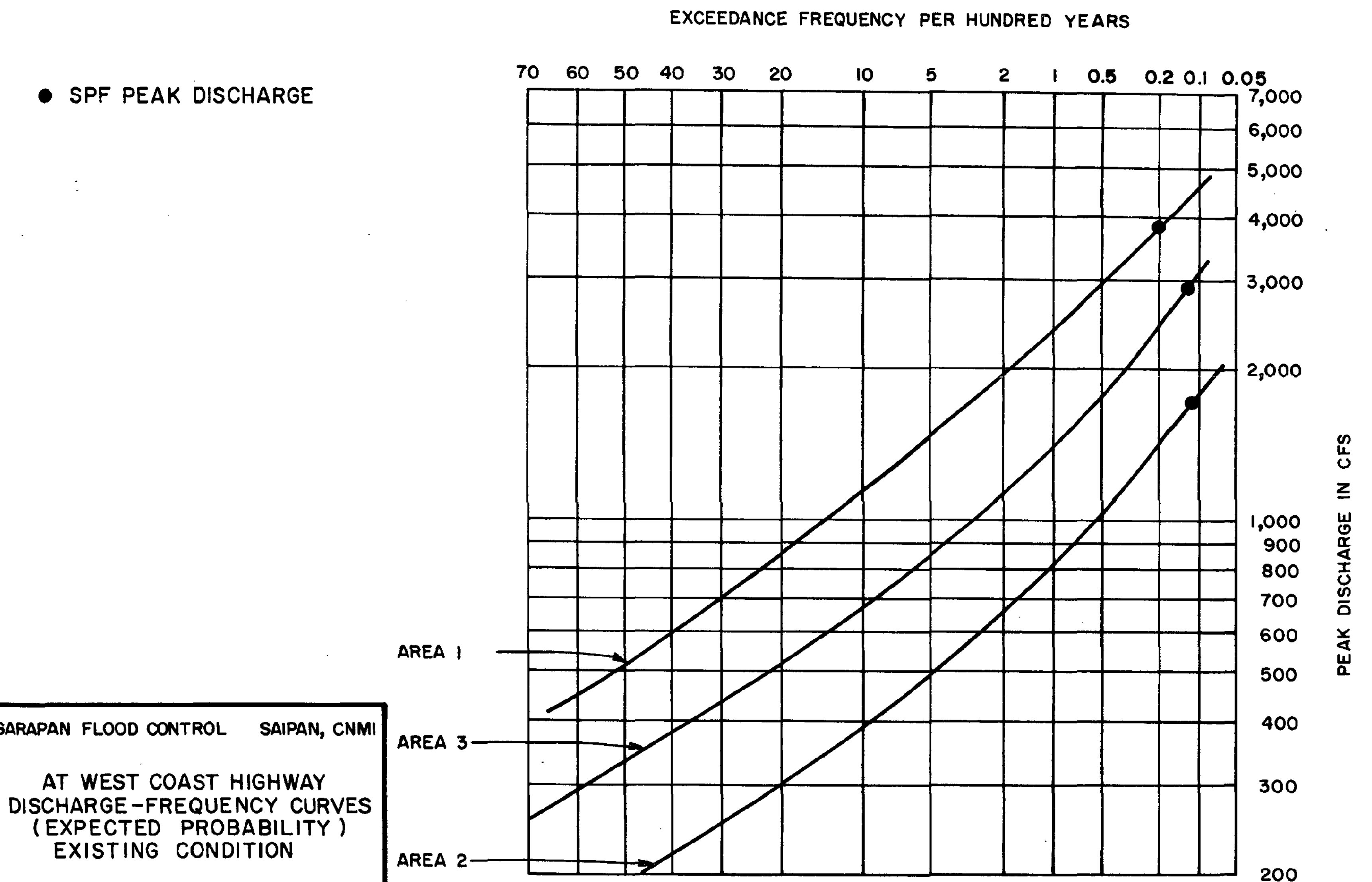
U.S. ARMY ENGINEER DISTRICT, HONOLULU



GARAPAN FLOOD CONTROL
SAIPAN, CNMI

STREAM GAGE LOCATION

U.S. ARMY ENGINEER DISTRICT, HONOLULU

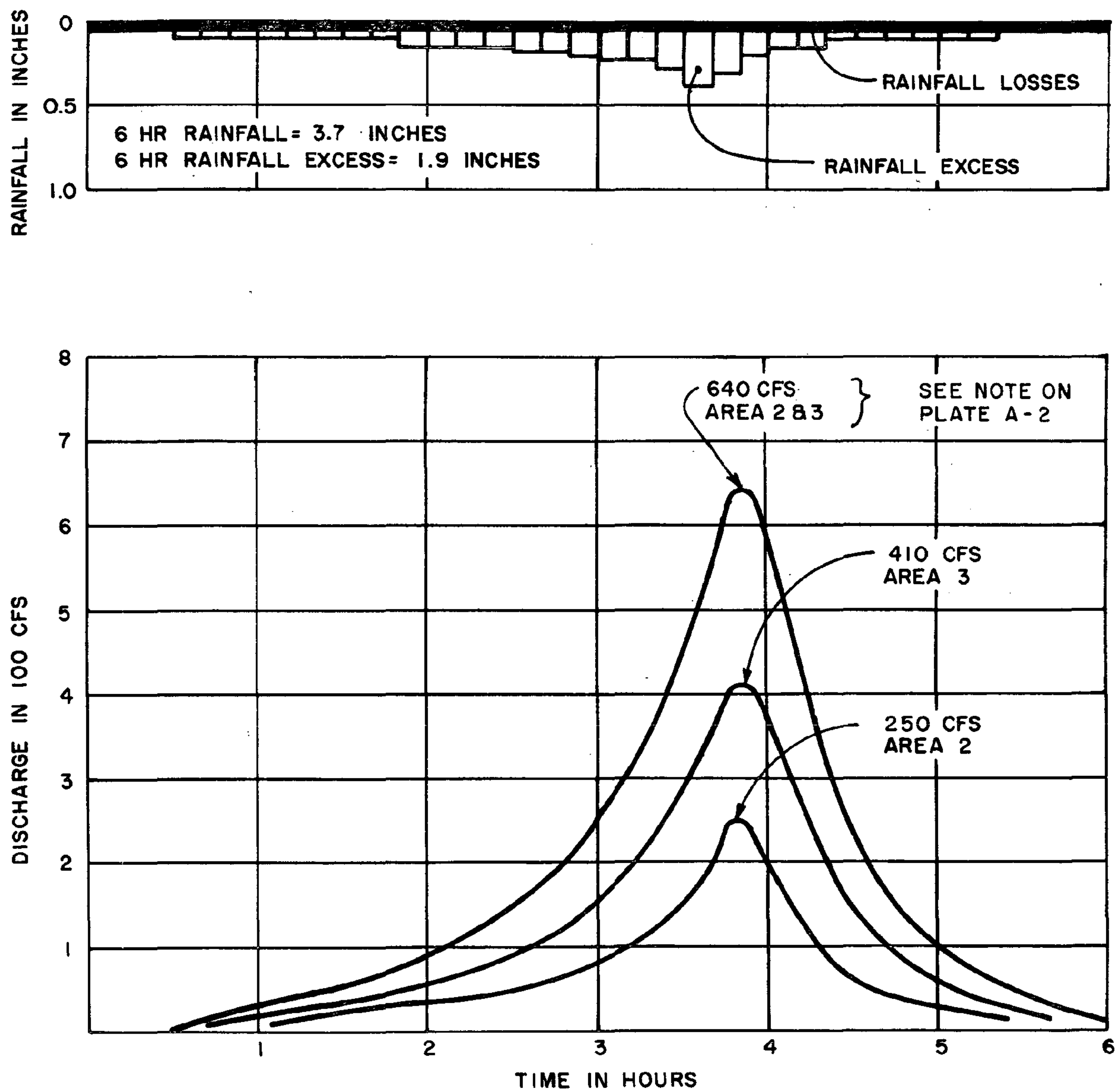


GARAPAN FLOOD CONTROL SAIPAN, CNMI

AT WEST COAST HIGHWAY
DISCHARGE-FREQUENCY CURVES
(EXPECTED PROBABILITY)
EXISTING CONDITION

U.S. ARMY ENGINEER DISTRICT, HONOLULU

NOTE:
FLOOD HYDROGRAPH FOR AREA 1 (FUTURE PROJECT CONDITION) IS SAME AS SHOWN ON PLATE A-9 SINCE NO DEVELOPMENTS ARE PLANNED FOR AREA 1.

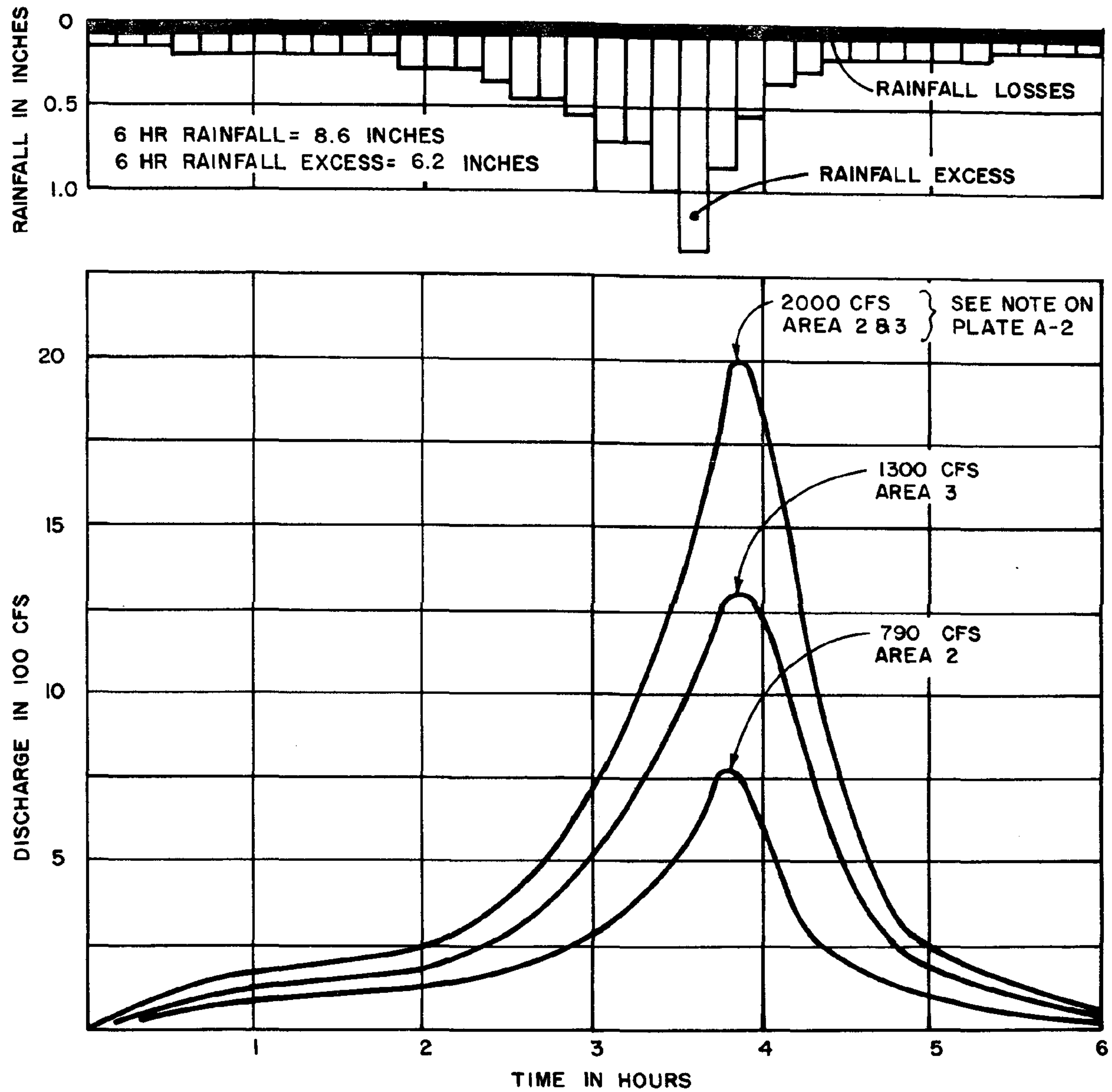


GARAPAN FLOOD CONTROL SAIPAN, CNMI

2-YEAR FLOOD HYDROGRAPHS
FUTURE PROJECT CONDITION

U.S. ARMY ENGINEER DISTRICT, HONOLULU

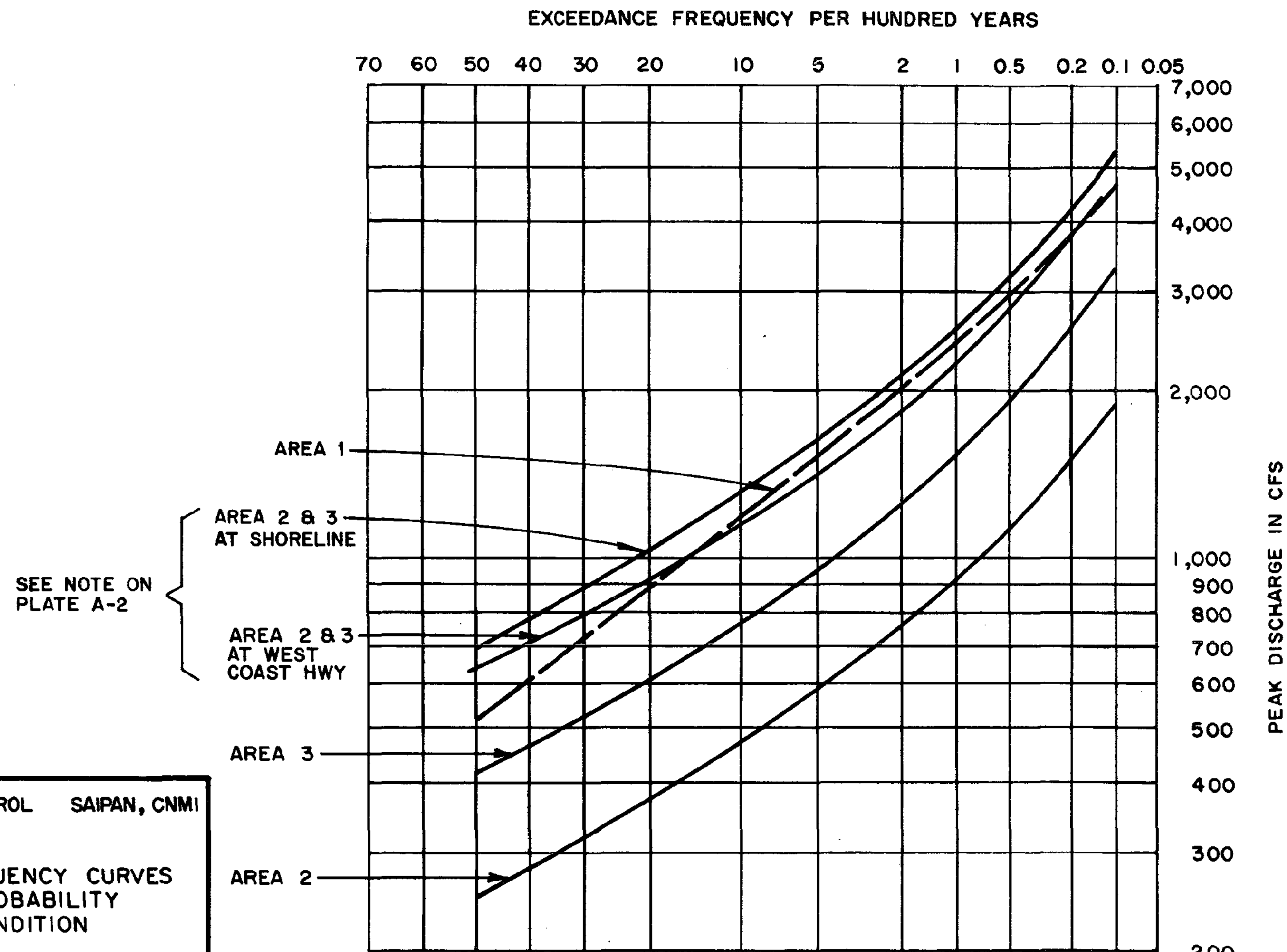
NOTE:
FLOOD HYDROGRAPH FOR AREA I (FUTURE PROJECT CONDITION) IS SAME AS SHOWN ON PLATE A-10 SINCE NO DEVELOPMENTS ARE PLANNED FOR AREA I.



GARAPAN FLOOD CONTROL SAIPAN, CNMI

100-YEAR FLOOD HYDROGRAPHS
FUTURE PROJECT CONDITION

U.S. ARMY ENGINEER DISTRICT, HONOLULU

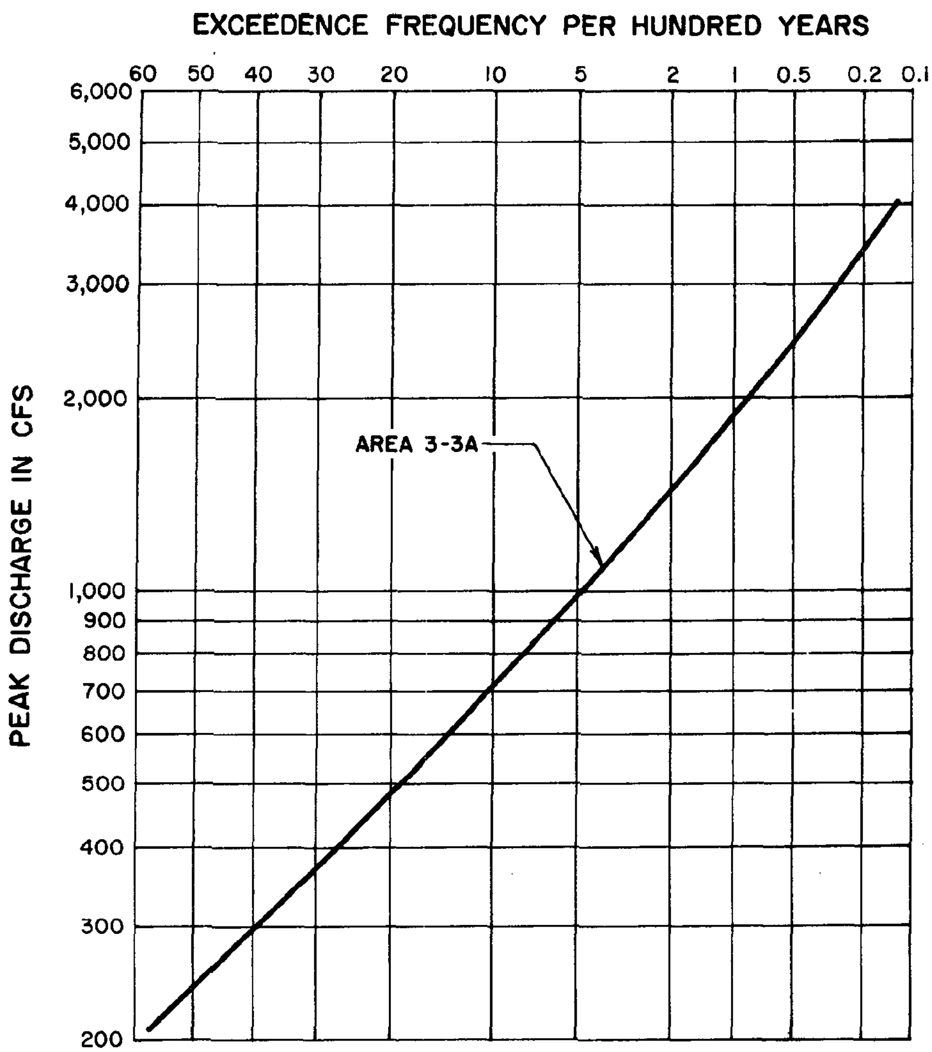


GARAPAN FLOOD CONTROL SAIPAN, CNMI

DISCHARGE-FREQUENCY CURVES
EXPECTED PROBABILITY
FUTURE CONDITION

U.S. ARMY ENGINEER DISTRICT, HONOLULU

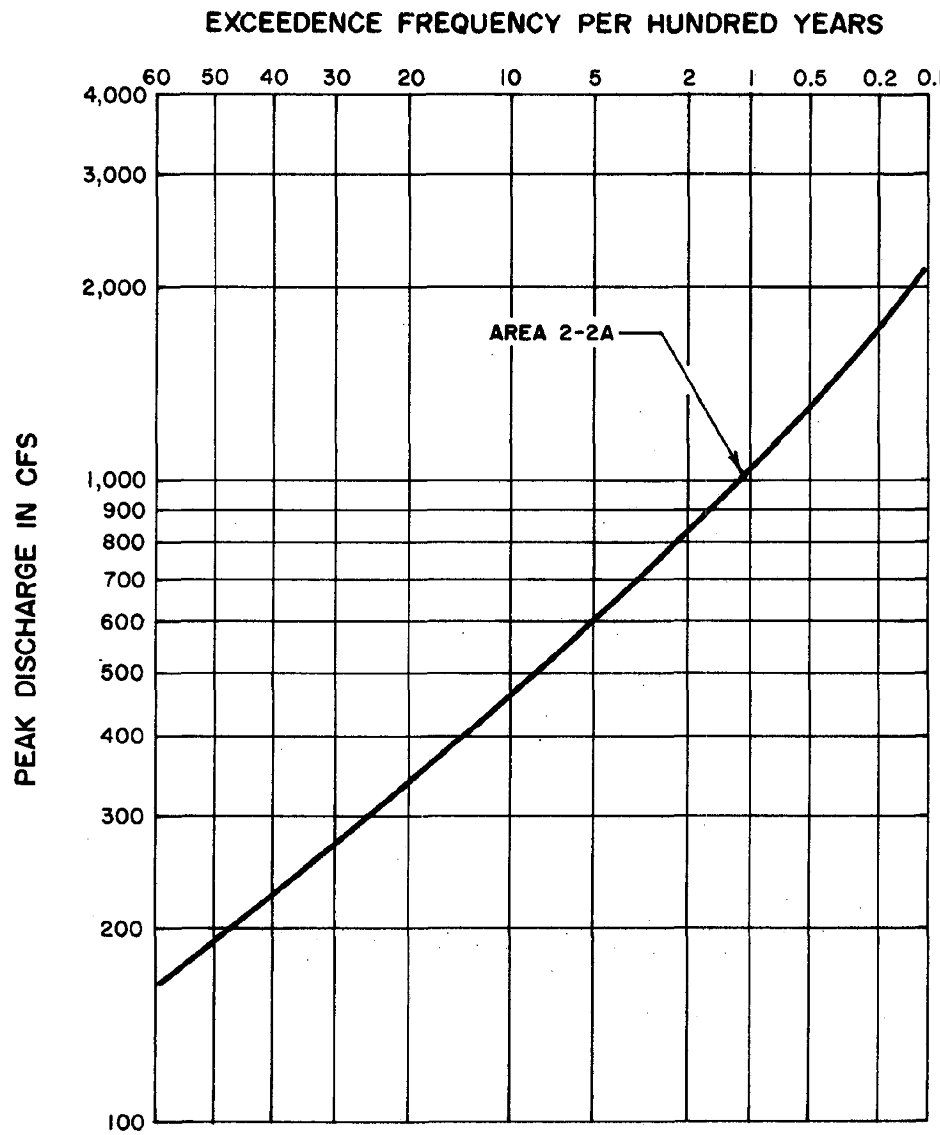
PLATE A-23



GARAPAN FLOOD CONTROL SAIPAN, CNMI

DISCHARGE-
FREQUENCY CURVE
(EXPECTED PROBABILITY AT SHORELINE)
FUTURE CONDITION-NO PROJECT

U.S. ARMY ENGINEER DISTRICT, HONOLULU



GARAPAN FLOOD CONTROL SAIPAN, CNMI

DISCHARGE-FREQUENCY CURVE

(EXPECTED PROBABILITY AT SHORELINE)
FUTURE CONDITION-NO PROJECT

U.S. ARMY ENGINEER DISTRICT, HONOLULU

Garapan Flood Control

Saipan, CNMI

GEOLOGY AND SOILS

Appendix B

APPENDIX B
GEOLOGY AND SOILS

TABLE OF CONTENTS

GEOLOGY AND SOILS APPENDIX

REGIONAL GEOLOGY

1. The island of Saipan is small in size, 13 miles long, four miles wide, comprises 48 square miles of dry land and has considerable geographic diversity. The dominant topographic feature is an axial ridge, or highland that extends through the northern three fourths of the island and reaches 1,555 feet elevation near the center of the island. A coral limestone barrier reef and lagoon (1/4 to 2 miles wide) borders the island on the west. The barrier reef changes to a fringing reef at both ends of the island. A narrow fringing reef encircles much of the rest of the island.

2. Closely spaced and generally deep valleys dissect and fissure most of the central portion of the axial ridge to expose volcanic and other igneous rock. Elsewhere the exposed rocks include tuffs and other pyroclastic fragmental rocks which have been reworked into sandstones and conglomerates.

3. The island consists of a series of limestone benches and scarps off-lapping on the volcanic rock basement. Three principal sets of benches or terraces are recognized according to elevation and intervals of terrace formation: An upper set of terraces with surfaces around 500 feet and higher elevation, an intermediate set of terraces with surfaces between 100 and 500 feet elevation, and the late or lower set of terrace surfaces below 100 feet elevation. A solution notch five to eight feet above present sea level is recognized as the six-foot eustatic stand of the sea that may correlate with the late post glacial warm period. Cloud, et al (Reference a) gives carbon-14 determinations that suggests an age order of 19,000 to more than 30,000 years for the most recent limestone formations. The oldest rocks are estimated to be about 58 million years old.

4. The terraces that dominate the terrain pattern of Saipan are nearly horizontal or slightly sloping benches, separated by seaward facing scarps or steeply sloping surfaces. The terraces below 100 feet are attributable to shifts of sea level, caused by melting and accretion of Pleistocene ice. The many changes in the relative position of land and sea that resulted in bench cutting at higher elevations may be tectonic effects, or even in part actual sea-level changes due to factors other than glacial. Nearly everywhere the surfaces of the limestone are pitted, pinnacled, creviced, cavitated (sinks and karst topography) and ridged from the action of water, aided by organic acids from the dense vegetation. Caves and sinks are formed from solvent ground water. Rain that falls on the porous and pervious limestone beds moves almost directly downward either to underlying impervious layers or to a water table which is in hydrostatic balance with the sea in accord with the principles of the Ghyben-Herzberg lens.

GEOMORPHOLOGY

5. Saipan has been divided (Reference a) into six principal geomorphic divisions and 25 distinct smaller parcels of terrain. The six major land forms are:

the terraced limestone uplands
the low limestone platforms
the lower terraced benches
the east central (Donni) clay hills
the south eastern coastal fault ridges
the western coastal plain

6. The proposed flood control project is located on the Western Coastal Plain which extends along the entire west side of the island. The western coastal belt ranges from 3,000 feet to less than 1,000 feet wide, and includes a total area of about four square miles of limesand (also classified as coral limestone sediments predominately sand sizes) and artificial man-made sanitary fills, heterogeneous mixtures of all kinds of coral and man-made debris. Filled terrain ranges from dredged marine sediments, random land fills, sanitary land fills, area and landscape grading to limited selected fills with controlled compaction. The so called limesands range from very fine to very coarse grained, are gravelly at some places and contain many mollusk shells and Foraminifera. They resemble present beach lagoonal sands except that they extend to altitudes as high as 15 feet or more. The sands rest upon a westward-sloping, limestone platform that is part of the low limestone platform, the hilly terrain on the east side of the Coastal Plain. The low, sloping limestone platform was once continuous with the Tanapag bench along the south side of Saipan. However, it was faulted downward about 20 feet to the west in late Pleistocene or early Recent time. The fault movement observable in the hills took place about 3,000 years ago (Reference a). The sandy beach and bar deposits forming the dry-land beach deposits around the marsh accumulated in the last 3,000 years by normal intertidal factors, water, wind and storm all contributing to some degree in the production of a genetically complex but physically rather simple blanket of limesand.

7. Carbon-14 analysis of a pelecypod shell collected from 1.5 feet below the surface of undisturbed limesands gives a corrected age of 1730 years (Reference a).

SEISMICITY

8. Saipan is in a most active seismic area on the eastern edge of the Philippine Plate between the Marianas and Japan trenches on the Cicum Pacific seismic belt. Many earthquakes of low magnitudes occur throughout the year with sufficient energy to cause settlement and consolidation in loose, low-density sediments. The earthquake history of Saipan since 1800 records two major disasters (actual magnitude not available) in 1849 and 1902. The Guam observatory lists 83 earthquakes since 1902 with magnitude of six or greater on the Richter scale. Because the area is seismically active, it is reasonable to assume that earthquakes of this magnitude or greater will occur again. Government design manual TM 5-809-10 dated April 1973 shows Saipan located in seismic probability Zone 3 with a design maximum acceleration of 0.33g. and a corresponding approximate magnitude of 7 on the Richter scale.

SUBSURFACE CONDITIONS

9. Subsurface explorations will be performed at a later date pending a preliminary determination of project feasibility. Based on the logs of test

pits 10 and 11 contained in Geo-Engineering and Testings 18 December 1978, a soil investigation report for the 48-unit Mihaville Housing Project (Reference e) located east of West Coast Highway, foundation materials along the diversion channel consist of approximately 1-foot of reddish-brown silt (MH) underlain in turn by silty sandy coral gravel (GM), silty gravelly coral sand (SM) or gravelly silt (MH), and coral limestone. Top elevations of the test pits are shown at (+)2.5 and (+)2.4 mean sea level, respectively. However, recent conversations with Geo-Engineer's principal indicated that the elevations shown are not reliable since no topo survey was available at the time of the explorations. Consequently, top elevations of (+)6.0 mean sea level were assumed for the two test pits to agree with topo surveys now available.

10. Based on borings and test pits performed by the Government in the Susupe-Chalan Kanoa area and other borings performed by Geo-Engineering in the Garapan fishing harbor area (Reference c), foundation materials along the outlet channel are assumed to consist of loose to medium dense limesands (SM to GP) overlying coral limestone.

11. Coral limestone may or may not exist within the limits of required excavation of the outlet channel. Vertical and lateral limits of coral limestone if present along the outlet channel will be determined by future subsurface explorations.

PRELIMINARY SOIL VALUES

12. This project will be primarily in excavation (cut) with minimal fill for freeboard requirements. For preliminary design purposes, foundation materials can be taken as cohesionless and the following soil parameters assumed. Soil parameters will be subject to review and revision upon completion of future subsurface explorations and laboratory soils testing.

$$SAT = 120 \text{ pcf}$$

$$M = 110 \text{ pcf}$$

$$0 = 30^{o}$$

$$C = 0 \text{ psf}$$

DESIGN CONSIDERATIONS AND ANALYSIS

DIVERSION CHANNEL

13. Based on available soils data and in keeping with Geo-Engineering's recommendations on the MIHA housing project, preliminary side slopes (cut and fill) of 1V on 2H are recommended for the trapezoidal concrete diversion channel. Side slopes will be subject to verification by detailed stability analysis upon completion of future subsurface exploration and laboratory soils testing work. A 12" layer of bedding material should be provided for drainage beneath the concrete slope and invert lining. Weepholes should be provided at minimum 8'-0" on-centers along the base of the slope lining for positive relief of excess hydrostatic pressures. Unlined portions of cut and fill slopes above the groundwater table should be grassed for erosion protection.

OUTLET CHANNEL

14. Based on available subsurface data, the outlet channel will be excavated through limesands and possibly coral limestone. Pending verification by detailed stability analyses upon completion of future subsurface exploration and laboratory soils testing, preliminary side slopes of 1V on 2.5H are recommended for the outlet channel. Slope and invert protection consisting of 18 inches of riprap over 9 inches of bedding are recommended for erosion protection in accordance with EM 1110-2-1601, Hydraulic Design of Flood Control Channels and ETL 1110-2-120, Additional Guidance for Riprap Channel Protection. Riprap design was based on a specific gravity of 2.3 for coral limestone rock, discharge of 2,950 cfs and velocity ranging from 7.0 to 8.9 fps.

15. Riprap will be provided for all channel slopes and invert situated on limesands. Should competent coral limestone be encountered in the lower limits of the cross sections, slope riprap will be terminated and keyed into the underlying coral limestone at the point of contact. Similar to the diversion channel, unlined portions of cut and fill slopes above the groundwater table will be grassed for erosion protection.

CONSTRUCTION CONSIDERATIONS

SITE PREPARATION AND FILL COMPACTION

16. Areas to be graded should be cleared of vegetation, grubbed and stripped to remove weak organic surface soils, large roots and other organic debris or trash. Areas to receive fill should be benched into firm soils or rock where slopes prior to grading exceed a steepness of 1V on 4H. Pockets of unusually soft or compressible soils should be removed in the process of benching.

17. Following site preparation, fills should be placed in lifts no thicker than nine inches loose thickness, moisture conditioned as necessary and compacted to minimum 95 percent of ASTM D 1557, Method D maximum density for cohesionless materials and minumum 90 percent of maximum density for cohesive materials.

CHANNEL EXCAVATION AND RIPRAP CONSTRUCTION

18. Dewatering will not be mandatory for channel excavation and riprap placement. However, if caving of loose foundation limesands becomes a problem during excavation, the contractor may elect to dewater to facilitate excavation. Riprap stone protection should be installed as the channel excavation progresses to minimize the exposure of the unprotected open excavation to unexpected flood flows. To the extent feasible, excavation and riprap placement should begin at the upstream end of the project and proceed downstream to minimize sediment accumulation in previously completed sections. Installation of a silt curtain or other structure across the mouth of the outlet channel will be required to minimize contamination of offshore waters during the excavation of the channel outlet.

DEWATERING FOR CONCRETE PLACEMENT

19. Dewatering will be required for concrete placement for portions of structures lying below the groundwater table. Where practical, consideration should be given to use of precast units to eliminate the need for dewatering.

PHASE CONSTRUCTION

20. Phase construction will be necessary for construction of the various culvert structures across Beach Road, West Coast Highway and other local streets. Since Beach Road and West Coast Highway are parallel roadway systems only 1,000' to 1,500' apart, local diversion of traffic from one roadway to the other could be used effectively to permit construction of the culvert structures. Alternatively, a temporary bypass could be provided immediately alongside each highway. Existing local streets could be incorporated into the temporary bypass system where possible.

21. Use of precast culvert sections would expedite construction of the roadway crossings, minimize interruption of vehicular traffic and eliminate problems associated with dewatering.

SPOIL DISPOSAL SITES

22. The volume of excess excavated materials on this project is between 150,000 and 200,000 cubic yards. Two possible sites are being considered by the Department of Public Works, Commonwealth of the Northern Marianas Islands for disposal of cleared and grubbed material and excess excavated materials. They are: 1) a low area east of West Coast Highway across from the American Memorial Park and 2) a proposed sanitary landfill site east of West Coast Highway, approximately one-quarter of a mile south of the Sugar Train. Both sites are within three miles of the project. The presence of numerous large trees which must be protected against damage at the first site may preclude its practicability as a disposal site. Since the Department of Public Works has no firm timetable for opening the sanitary landfill at the second site, its availability is also uncertain at this time. A definite disposal site will be designated during the plans and specifications stage.

SOURCES OF CONSTRUCTION MATERIALS

EXCAVATED MATERIALS

23. Fills for this project are minimal and only required to the extent of providing the necessary freeboard allowance. Excavated mateials will be suitable for fill construction. The volume of material from the required excavations will be more than ample to satisfy fill requirements.

QUARRIES AND BORROW PITS

24. More than 50 quarries and borrow pits were opened on Saipan during World War II. Most of the sites have been abandoned and are now overgrown with vegetation or obscured by subsequent development. Reopening these abandoned quarries will require considerable investigations and development work.

25. All borrow pits and quarries on Saipan are controlled by the Commonwealth of the Northern Marianas and are leased for a fixed period (normally five years) on a competitive bid basis. Two quarries presently in operation on Saipan are the Black Micro Quarry at Marpi and the Sablan Quarry on Capital Hill in Tanapag. The limestone at these two quarries varies from rubble to well-bedded coral limestone breccia. The limestone is white to tan and yellow in color, poorly indurated, fossiliferous and crumbly, requiring only a small amount of blasting for removal. The limestone has been irregularly dissolved by water leaving pinnacled solution surfaces. Fresh rock is overlain by residual red or brown clay of high plasticity in thickness ranging from a few inches to more than ten feet. There is a sharp contact between the clay and the underlying bed rock. A description of materials available at each of the above quarries are described below.

(a) Black Micro Quarry at Marpi. This operating quarry is presently the best source for riprap or armor stone on Saipan. It produces a dense coral limestone rock with specific gravity (BSSD) in the order of 2.6. A stockpile of approximately 500 pieces of stone, 3' to 5' in nominal diameter were observed at the site in December 1979. Approximately 15 percent of the stone in the stockpile ranged in size from 4' to 5' and the remaining 85 percent ranged in size from 3' to 4'. Quarry personnel said approximately 200 to 300 pieces of stone in sizes ranging from 3' to 5' are recovered each month of operation. A higher rate of recovery could be obtained by changing the drilling and blasting pattern which is presently tailored for production of concrete aggregate. Stones less than 3' in nominal diameter comprise the bulk of the stone recovered from the quarry. Stones of this size are readily accommodated by the crusher in the production of concrete aggregate. A crushing/screening plant and a concrete plant are located at the site. Concrete aggregate produced meets the requirements of ASTM C-33. However, washing and scrubbing will be required to remove adhered fines.

(b) Sablan Quarry in Tanapag. This quarry produces coral limestone aggregate for concrete and asphaltic concrete. A crushing/screening plant, concrete plant and asphalt plant (temporarily out of operation) are located at the site. Quarry personnel said concrete aggregate produced meets the requirements of ASTM C-33. Stone sizes available at this quarry are generally less than 3 feet. A small stockpile of stone was observed at the site during May and December 1979. Specific gravity of the stone ranges from 2.1 to 2.5. Quality of the rock varies widely and handling costs involved in sorting out the few acceptable pieces may rule out consideration of this quarry as an economical source of riprap or armor stone.

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i. U.S. Defense Mapping Agency, Hydrographic Center, Hydrographic Map of Saipan Harbor, DMA Stock Number 81AHA81076, Scale 1:12000, 4th edition, 25 March 1974.

GARAPAN FLOOD CONTROL
SAIPAN, CNMI

ENGINEERING INVESTIGATIONS, DESIGN AND COST ESTIMATES

APPENDIX C

APPENDIX C

ENGINEERING INVESTIGATIONS, DESIGN AND COST ESTIMATES

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ENGINEERING INVESTIGATIONS, DESIGN
AND COST ESTIMATES APPENDIX

HYDRAULIC DESIGN

GENERAL HYDRAULIC CRITERIA

1. Guidance. The hydraulic design follows the US Army Corps of Engineers' Engineering Manual 1110-2-1601, "Hydraulic Design of Flood Control Channels," dated 1 July 1970.

2. Computations. Standard hydraulic theories were applied in the analysis. Descriptions are available in standard hydraulic texts and handbooks. The computational procedure generally follows Method 1, Engineering Manual 1110-2-1409, "Backwater Curves in River Channels," dated 7 December 1959. The actual computations were performed utilizing principally the Corps' generalized computer program HEC-2 "Water Surface Profiles," dated November 1976.

3. Level of Protection. A major consideration in the determination of a suitable level of protection is the potential effect on the health and safety of the community. For potential measures in urban areas with high levees, floodwalls or high velocity channels subject to potential catastrophic effects, the standard project flood may be the recommended level of protection. Lower levels of protection may be recommended for less urbanized areas or areas not subject to a catastrophe resulting from floods exceeding the design flood.

4. In the alternative designs developed, the average channel velocities are less than 10 feet per second (fps). Overtopping of the embankments would produce a low velocity sheet flow over the surrounding areas with no potential catastrophic results. Therefore, the standard project flood is not considered a suitable design discharge for the project. The channel design, however, must also provide a technically feasible degree of protection. For this reason, discharges less than the two percent discharge are not considered at this stage of the study. Flooding in the lower Garapan area is a result of low velocity flows and localized ponding. Based on preliminary benefit maximization studies, and in view of the nature of the type of flooding problem involved, the two percent frequency flow was adopted as the tentative design flood.

HYDRAULIC PARAMETERS

5. Hydraulic Cross Sections. The typical sections utilized in the design are shown on appropriate figures of the main report. The sections were selected based upon the stability characteristics of the natural ground, and of the lining materials, the constraints in available rights-of-way, and the costs in potential construction and maintenance. The sections are intended to confine and convey flowing waters up to the specified design discharge.

6. Roughness. The conservation of energy principle states that the total energy head at a upstream location equals the total energy head at the downstream location plus energy losses. Energy losses include frictional losses estimated by Manning's roughness coefficient (n). Values utilized in the analysis are shown on Table C-1.

TABLE C-1. HYDRAULIC PARAMETER VALUES

Cross Section Type & Material	Type of Channel	Special Condition/Location	Side Slope	Mannings "n" Value	Maximum Velocity, Ft/Sec	Freeboard Feet
Trapezoidal						
Riprap	"A"	Alternative 1-3 outlet channels and 100-year plan diversion channel south of Island Power Road.	1V on 2.5H	.035	15.0	2
Grass	"B"	Alternative 1-3 diversion channels.	1V on 2H	.030	8.0	2
Riprap	"C"	Alternative 1-3 diversion channels south of Island Power Road.	1V on 2.5H 1V on 3H 1V on 4H	.035 .035 .035	15.0 15.0 15.0	2 2 3
Concrete	"D"	100-year plan diversion channel.	1V on 2H	.014	40.0	2.5
Rectangular						
Concrete	-	All culverts.	Vertical	.014	40.0	Varies*
Concrete	"E"	To contain hydraulic jump in area south of Island Power Road.	Vertical	.014	40.0	3.0

*See Table C-2

7. Culvert and Bridge Piers. At new culvert (Table C-2) locations, computations were performed using the HEC-2 bridge routine. Flow parameters utilized are as follows:

Class Flow	Parameter	Value
A	Pier shape coefficient, XK	1.05
A, C	Pier shape coefficient, XK	0.0 (No piers)
A	Effective obstructed pier width	Actual width +1.0 feet on each side
A, C	Pressure flow orifice loss coefficient, K	1.6

8. Permissible Velocities. The range in acceptable mean velocities is based on accepted hydraulic standards. Velocities in excess of limiting values may cause scour, damage, and excessive maintenance to the channel. Channel velocities in the areas with riprap lining are therefore, limited to 15 fps and to 8 fps in grass-lined channel areas. The flow velocities for the alternative plans are also shown on plates C-5 through C-8.

9. Freeboard. Freeboard is the computed vertical distance between the design water surface to the top of the channel wall or embankment. The freeboard considered in the design is dependent on the flow regime (rapid or tranquil), uncertainty in hazard (special physical conditions) and the lining material (concrete or rock). In most areas, a minimum freeboard of 2.0 feet is required except in high velocity flow areas where a 3.0-foot freeboard is recommended. These values of freeboard appear to be consistent with the above-mentioned parameters and the nature of the flood control system. Freeboard allowances for various channel sections are summarized in Table C-1.

10. Superelevation and Bend Radii. The rise in water surface as a result of centrifugal and gravitational forces on curved sections is based on guidance in EM 1110-2-1601. Simple circular curves are used in the design. The manual recommends that for subcritical flow channels, the centerline curve radius be a minimum of three times the design water surface topwidth. All channel curves in the design follow this minimum criteria. The superelevation coefficient "c" of 0.5 is utilized for tranquil flows.

11. Transitions. Transition in the channelized portions of the proposed improvements (including certain culvert locations) follow the recommended convergence and divergence wall flare rates. For mean channel velocities of less than 10 feet per second, the ratio of horizontal to longitudinal distance for each wall is held at a minimum 1:5. For velocities in the 10 to 15 feet per second range, the ratio is increased to a minimum of 1:10. There are no transitions where channel velocities exceed 15 feet per second.

12. At other culvert locations, wedge type transitions involving vertical wingwalls and sloped transitions to the trapezoidal channel section are being considered. These are generally less costly to construct, but the abrupt change in channel configuration results in additional flow disturbance and increased head losses. The coefficients for contraction and expansion losses are as follows:

TABLE C-2. CULVERT SIZES
(See Plates C-1 to C-6)

Alternative	Culvert	Station	Dimensions H (Ft) X W (Ft)	Avg. Invert Elev (Ft)	Freeboard (Ft)
1	A	7+20 to 7+60	Two Cells: 11 x 17 11 x 17	-6	3.1
1	B	1+20 to 2+10 (RT)	9 x 30	0.3	4.5
1	C	1+30 to 2+00 (LT)	9 x 15	0.5	4.0
1	D	4+70 to 5+00 (LT)	7.5 x 25	1.4	1.5
2	E	5+30 to 5+60	12 x 30	-7.3	3.7
2	F	20+90 to 21+90	9 x 30	-2.7	3.3
2	G	45+20 to 45+50	9 x 30	0.7	1.7
2	H	49+70 to 50+00	7.5 x 25	1.4	1.0
3	I	13+00 to 14+00	Two Cells: 9 x 20 9 x 20	-4.8	2.0
3	J	22+40 to 23+00	Two Cells: 7 x 20 7 x 20	-1.9	1.0
3	K	1+70 to 2+00 (RT)	8 x 20	-0.1	2.5
3	L	1+70 to 2+00 (LT)	8 x 25	-0.3	2.5
3	M	12+70 to 13+00 (LT)	9 x 20	0.7	2.4
3	N	17+20 to 17+50 (LT)	7.5 x 25	1.4	1.4

	Flow Regime	Contraction Coefficient	Expansion Coefficient
Gradual (Wall Flare 1:10)	Subcritical	0.30	0.50
	Supercritical	0.10	0.30
Gradual (Wall Flare 1:5)	Subcritical	0.30	0.75
	Supercritical	0.20	0.50
Abrupt (45^{o} angle wingwalls)	Subcritical	0.30	0.75
	Supercritical	0.30	0.70

13. Baseline Elevation. All computations are performed on existing topographic survey data. Elevations are based on mean sea level (MSL) datum. Backwater computations for sizing the outlet channels, start at an elevation equal to mean higher high water (MHHW) plus one-half foot for wind and wave set-up (0.8 feet plus 0.5 feet = 1.3 feet). Channel stability computations are based on an initial water surface elevation of (-)1.4 feet, which is equal to mean lower low water (MLLW).

COST ESTIMATES

14. Quantity computations for the alternative plans were determined from topographic maps completed in September 1979. The sources of construction materials are discussed in Appendix B - Geology and Soils, under "Sources of Construction Materials." A Guam-based contractor to do the work was assumed. Unit prices and wage rates are based on July 1980 price levels in Saipan.

15. Table C-3 summarizes the estimated costs for Plans 1 through 3.

TABLE C-3. SUMMARY OF FIRST COSTS

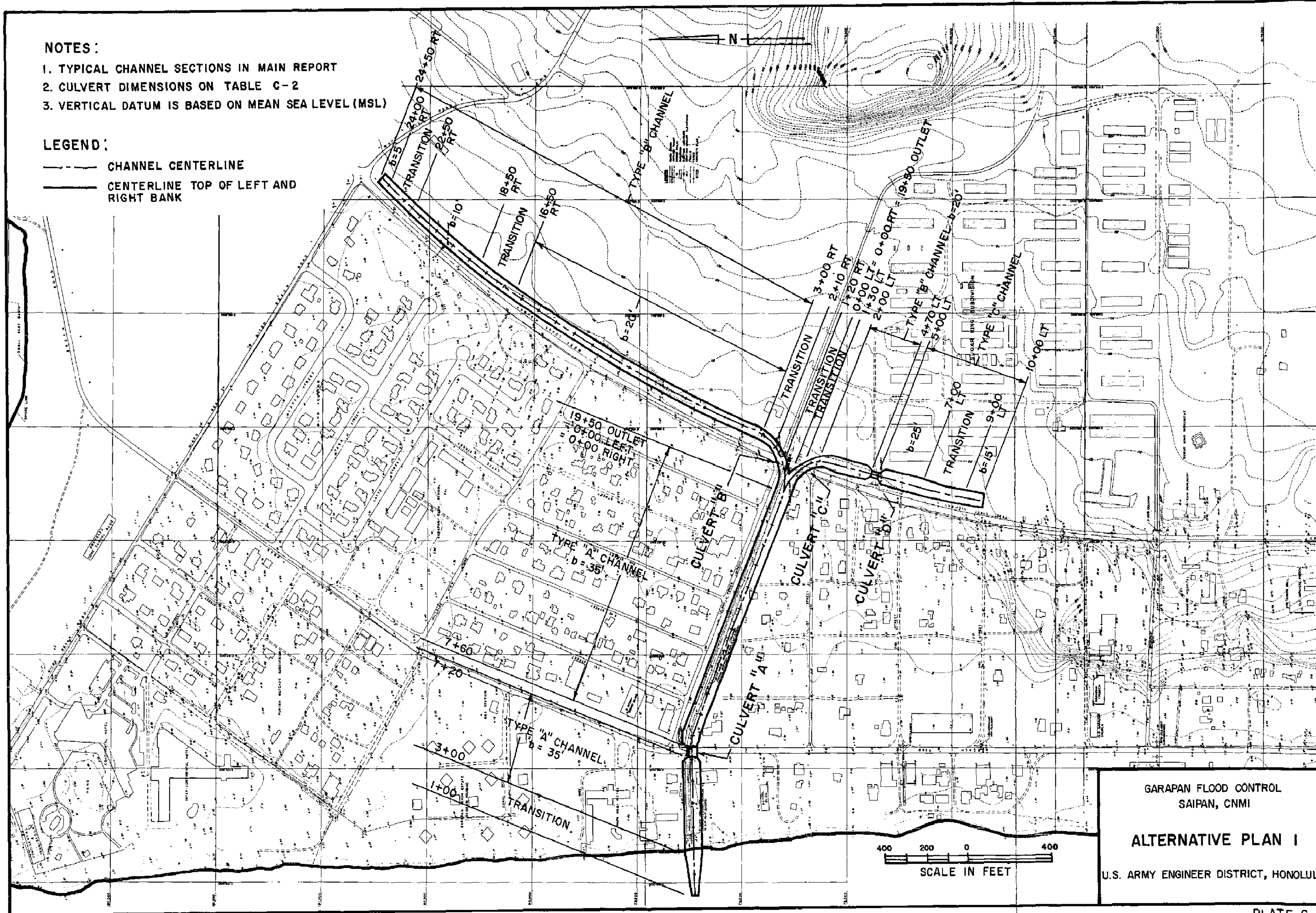
Item	Plan 1	Plan 2	Plan 3
Mobilization and Demobilization	$197,000	$197,000	$197,000
Clearing/Excavation	659,000	697,000	734,000
Channel Construction	691,000	1,176,000	1,053,000
Culvert Installation	669,999	542,000	740,000
Lands, Relocations, and Indirect Costs	309,000	90,000	197,000
Subtotal	$2,525,000	$2,702,000	$2,921,000
Contingency (20%±)	505,000	540,000	584,000
Engineering and Design	89,000	89,000	89,000
Supervision and Administration	106,000	111,000	119,000
Total Project First Cost	$3,225,000	$3,442,000	$3,713,000

NOTES:

1. TYPICAL CHANNEL SECTIONS IN MAIN REPORT
2. CULVERT DIMENSIONS ON TABLE C-2
3. VERTICAL DATUM IS BASED ON MEAN SEA LEVEL (MSL)

LEGEND:

- CHANNEL CENTERLINE
- CENTERLINE TOP OF LEFT AND RIGHT BANK



GARAPAN FLOOD CONTROL
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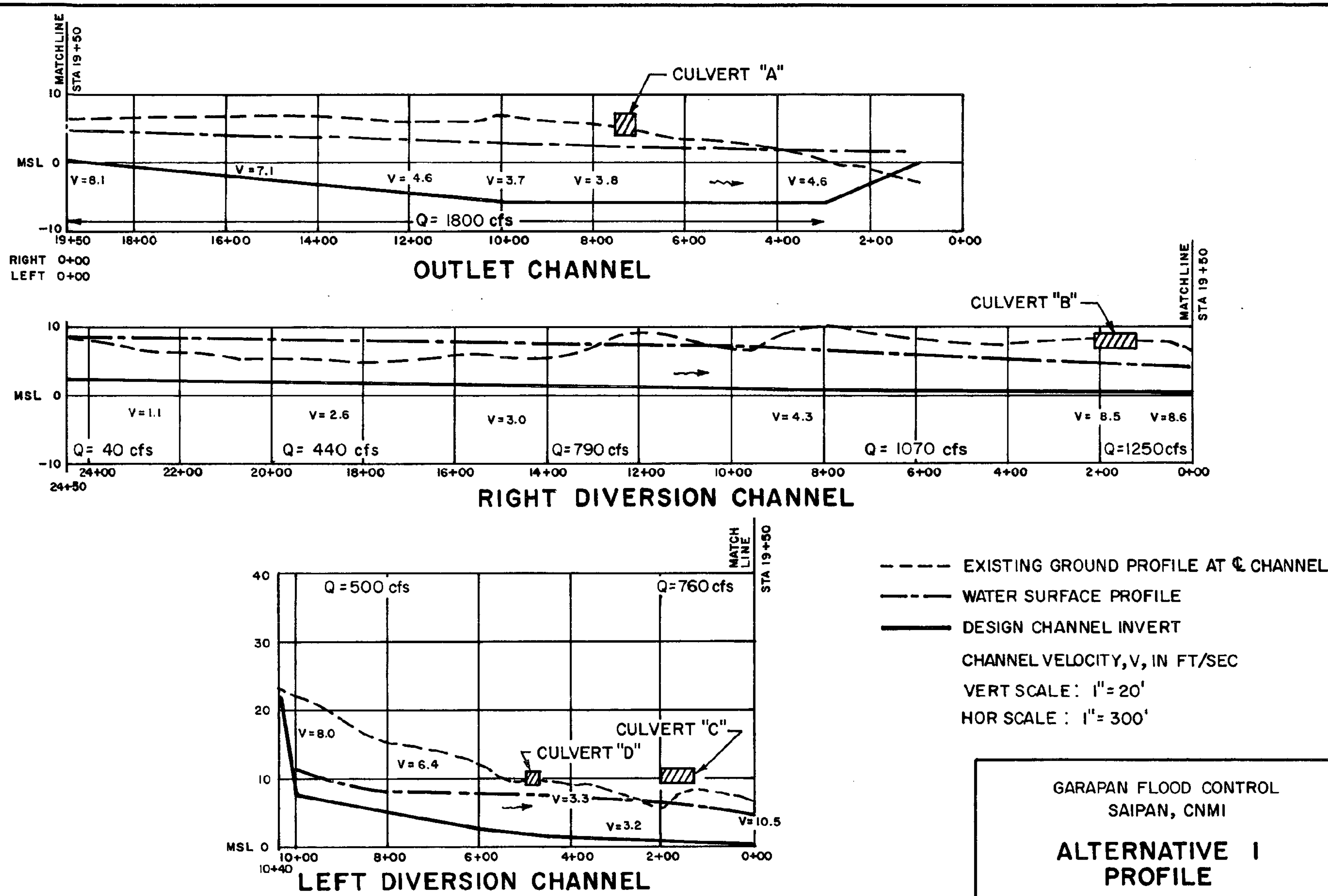
ALTERNATIVE PLAN I

U.S. ARMY ENGINEER DISTRICT, HONOLULU

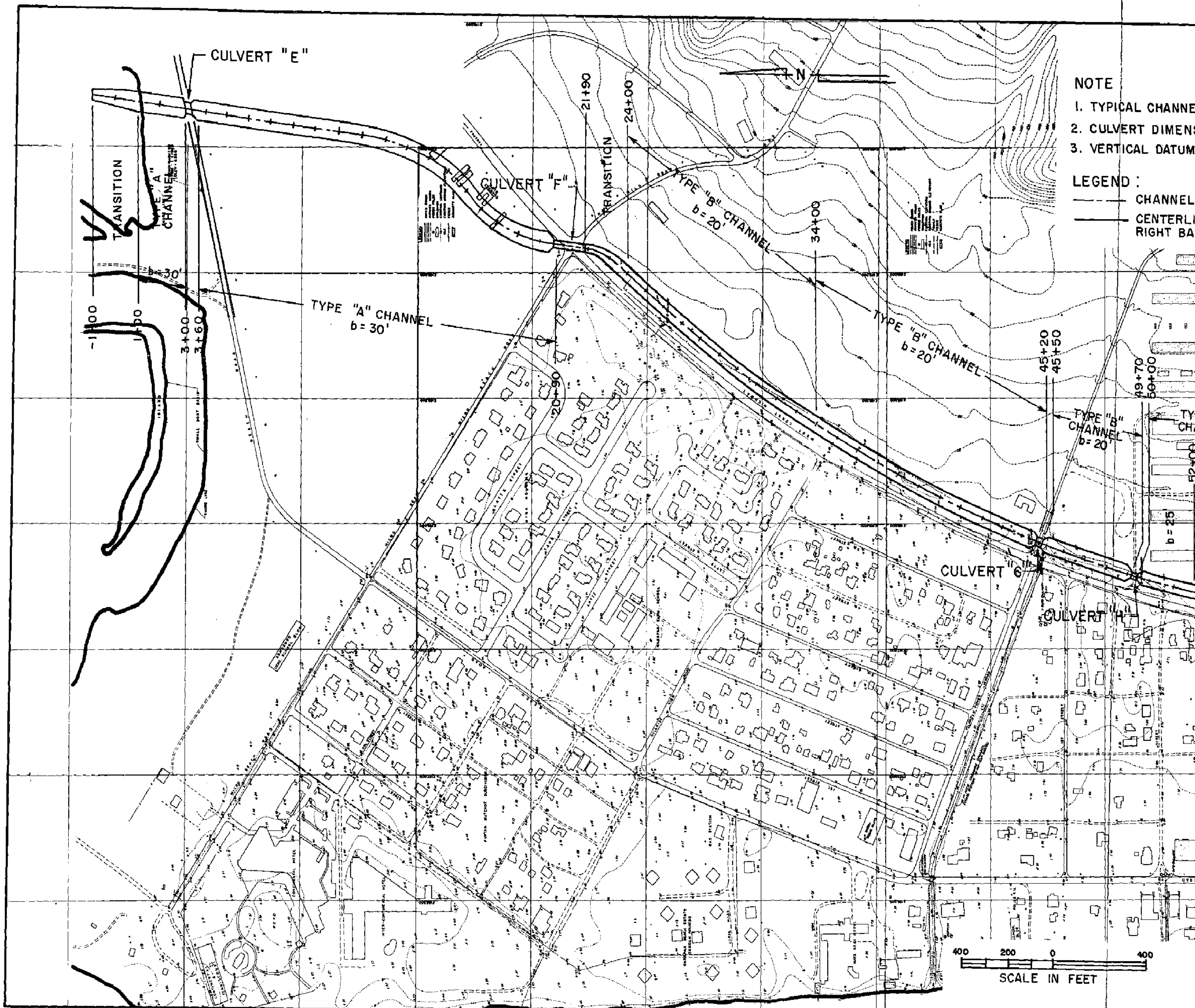
PLATE C-I



GARAPAN FLOOD CONTROL
SAIPAN, CNMI

ALTERNATIVE I
PROFILE

U.S. ARMY ENGINEER DISTRICT, HONOLULU



NOTE

1. TYPICAL CHANNEL SECTIONS IN MAIN REPORT
2. CULVERT DIMENSIONS ON TABLE C-2
3. VERTICAL DATUM IS BASED ON MEAN SEA LEVEL (MSL)

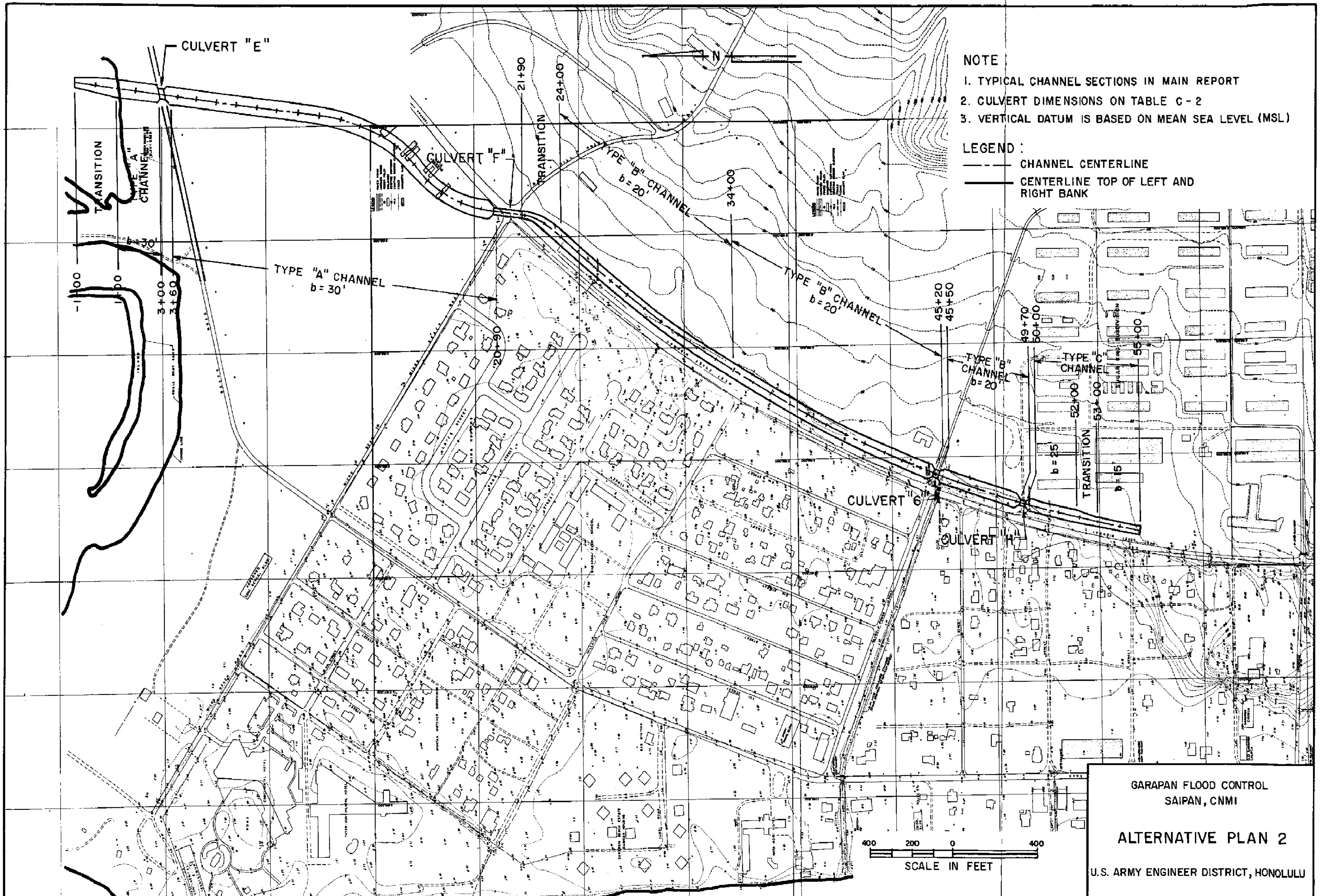
LEGEND:

- CHANNEL CENTERLINE
- CENTERLINE TOP OF LEFT AND RIGHT BANK

GARAPAN FLOOD CONTROL
SAIPAN, CNMI

ALTERNATIVE PLAN 2

U.S. ARMY ENGINEER DISTRICT, HONOLULU



NOTE

1. TYPICAL CHANNEL SECTIONS IN MAIN REPORT
2. CULVERT DIMENSIONS ON TABLE C - 2
3. VERTICAL DATUM IS BASED ON MEAN SEA LEVEL (MSL)

LEGEND :

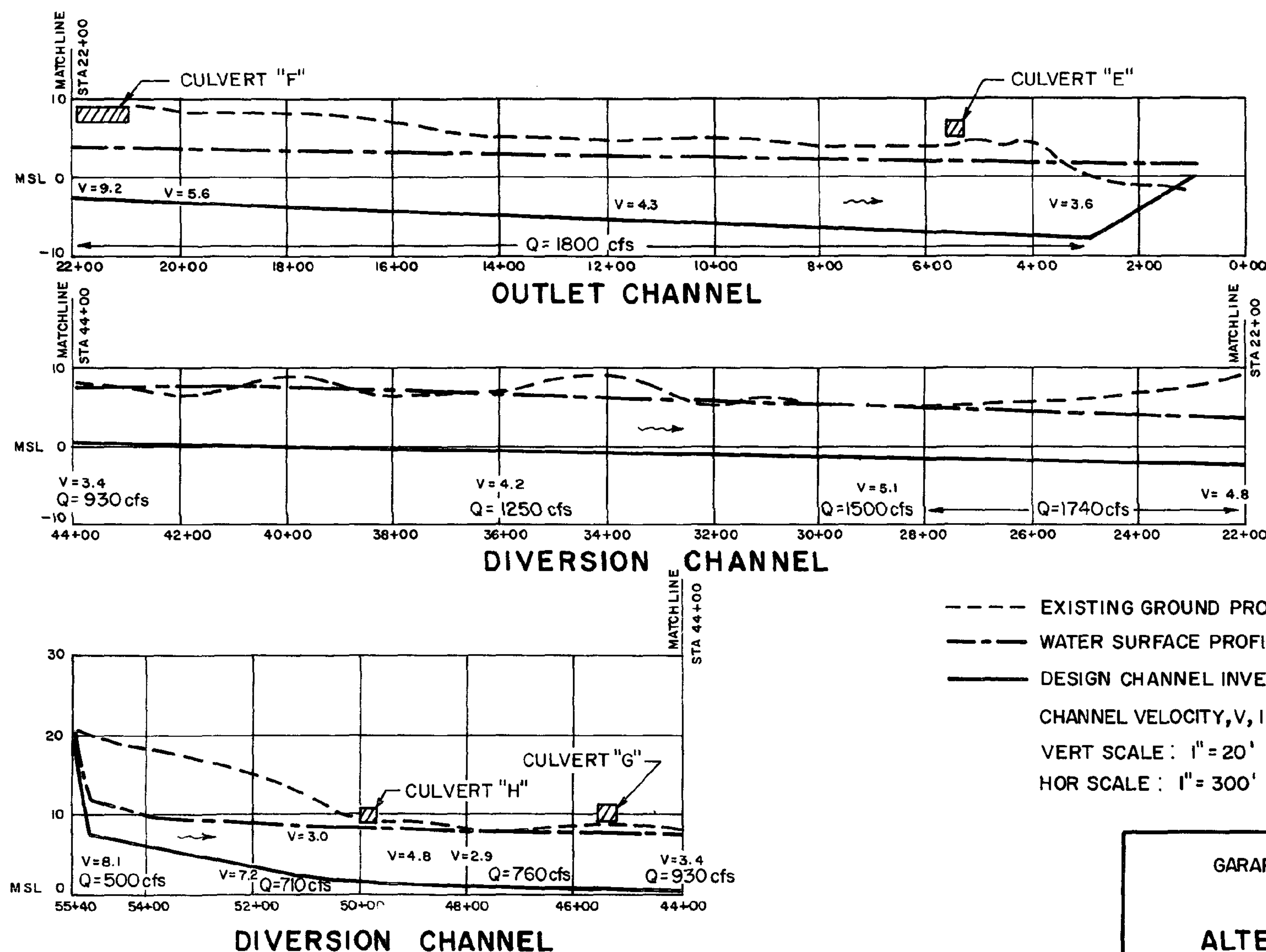
— - — CHANNEL CENTERLINE

——— CENTERLINE TOP OF LEFT AND RIGHT BANK

GARAPAN FLOOD CONTROL
SAIPAN, CNMI

ALTERNATIVE PLAN 2

U.S. ARMY ENGINEER DISTRICT, HONOLULU



EXISTING GROUND PROFILE AT ℄ CHANNEL

WATER SURFACE PROFILE

DESIGN CHANNEL INVERT

CHANNEL VELOCITY, V, IN FT/SEC

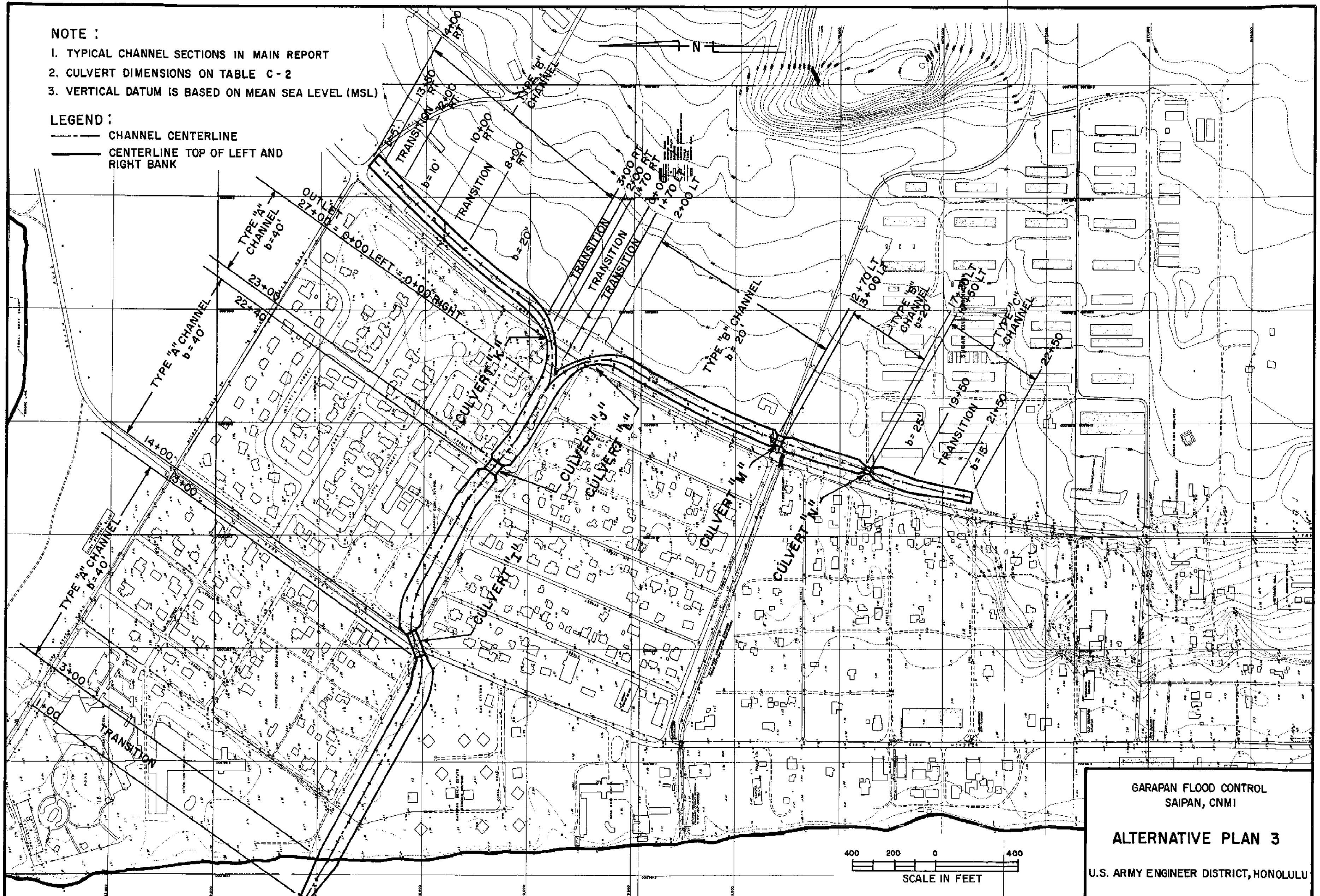
VERT SCALE: 1" = 20'

HOR SCALE: 1" = 300'

GARAPAN FLOOD CONTROL
SAIPAN, CNMI

**ALTERNATIVE 2
PROFILE**

U.S. ARMY ENGINEER DISTRICT, HONOLULU

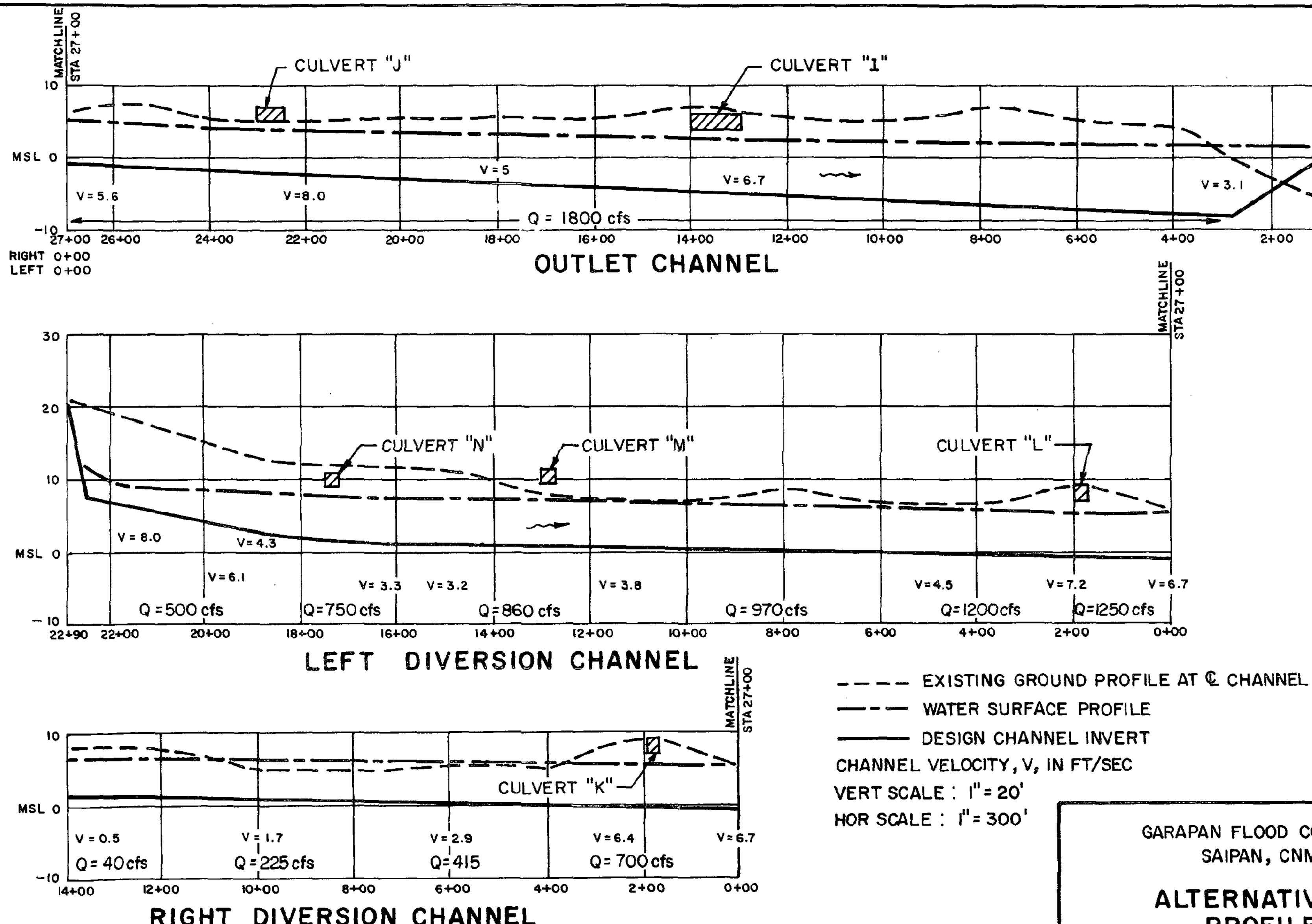


GARAPAN FLOOD CONTROL
SAIPAN, CNMI

ALTERNATIVE PLAN 3

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE C-5



GARAPAN FLOOD CONTROL
SAIPAN, CNMI

ALTERNATIVE 3 PROFILE

U.S. ARMY ENGINEER DISTRICT, HONOLULU

GARAPAN FLOOD CONTROL
SAIPAN, CNMI

ECONOMICS

APPENDIX D

APPENDIX D

ECONOMICS

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ECONOMICS

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ECONOMICS APPENDIX

METHODOLOGY

National Economic Development Objective. Floodplain management (including flood control and prevention) contributes to the National Economic Development (NED) objective by improving the net productivity of flood prone land resources. This occurs either by an increase in output of goods and services and/or by reducing the cost of resources.

Condition of Project Area. Each floodplain management plan under consideration is evaluated on a "with and without" project basis. The without condition is that most likely to occur without the specific plan and gives proper recognition of the effect of the flood hazard on the probable course of development. The adoption and enforcement of appropriate land use regulations pursuant to the Flood Disaster Protection Act of 1973 (PL 93-234) is assumed, both with and without a Corps plan. For purposes of evaluating structural components of a plan, rational economic use of the floodplain is assumed. Economic rationality assumes that users of the floodplain will attempt to maximize returns, and take actions with full knowledge of the flood hazard.

Project Costs. The total project NED costs include the first construction cost, contingency, indirect costs, and rights-of-way costs. The sum total is amortized over a 50-year economic life at 7-1/8 percent discount rate. The discount rates utilized are the prevailing rate established by the Water Resources Council for major water development projects. Added to the amortized first cost is the Operation, Maintenance, and Replacement (OM&R) costs. The sum of these two values is the average annual costs. This time stream of annual costs is compared to corresponding benefit values.

Benefit Components. The principal benefits for flood control facilities are inundation reduction benefits. These "benefits" are the net loss in income to the nation as a result of flooding, commonly measured as the physical damages, business losses, and emergency costs. The inundation reduction benefit is the value of reducing flood losses to activities which would use the floodplain without any plan. It is measured as the reduction in the amount of damages or related costs. The component elements are the economic life, the discount rate, the base year, and price level all related to the annual values of benefits and costs. The economic life of the alternatives evaluated will be fifty (50) years. This period is consistent with projects of this scope and type. The discount rate for current FY 1980 Federal water resources projects is 7-1/8 percent. The base year is the year any evaluated plan is expected to be operational. The base year for the analysis is 1982. All benefits and costs are evaluated in constant (1980) dollars and extrapolated to the base year. The July 1980 price level is the date of the relative price of goods and services evaluated.

Evaluation Process. Each evaluated condition may include potential land use changes, additional development and similar modifications which will alter the hydrologic response and potential economic damages. The benefit analysis involves interrelationship between hydrologic, hydraulic, and economic data and characteristics. Because of the variable nature of hydrologic events, the benefits are reflected in a time stream of damages prevented. The future stream of benefits is estimated by the multiplication of potential damages by corresponding flood frequencies and deducting the residual damages not prevented by the project.

PROJECT BENEFITS

General Description of Study Area. Garapan is undergoing rapid growth as mentioned in the main report. Developments within the study area is well underway; large tracts of open space for subdivision in the immediate future are no longer available. There are 338 buildings within the area and about 97 percent are residential. The remaining 3 percent consist of "neighborhood" type business and a police station. In addition, a nine-building elementary school sits in the heart of the area, and three multi-story hotels are located along the shoreline. Few smaller parcels of vacant land scattered throughout the area are zoned residential. The most recent flood of 18 August 1978, a 10-year to 30-year flood frequency had reported residential damages of $195,000 and commercial loss of $27,000, for a total of $222,000. None of the hotels were affected. There are no documents of damages from earlier floods within the study area.

Development of Depth - Percent Damage Curves. The records of damages from the flood of August 1978 are the only available source of damage data in Saipan and were used in deriving depth-percent damage relationships for structures and contents (see Table D-2). Damage data from the 82 residents in Garapan who completed a flood damage questionnaire was used in this tabulation. Table D-1 shows damages reported by principal subdivision in Garapan. Flood damage reaches are shown on Figure 5 of the main report.

TABLE D-1. DAMAGES REPORTED BY PRINCIPAL SUBDIVISIONS
DURING AUGUST 1978 FLOOD

Area	Structure Damage	Content Damage	Yard Damage	Total
Annex I	$24,000	$51,500	$6,100	$81,600
Annex II	$13,800	$4,100	--	$17,900
Puntan Mutchot	$21,000	$69,800	$4,900	$95,700
	$58,800	$125,400	$11,000	$195,200

It was not possible to correlate damage versus depth of flooding on a house-to-house basis. Consequently, representative percent structure or content versus depth curves were derived using the area totals. Pacific Ocean Division's urban damage computer program was used to calculate stage damage curves for residential units by reach. Index stages in each reach were selected as representative of the actual water surface that produced the reported damages. Percent damage curves were developed such that the predicted damages matched those reported as closely as possible. The actual and predicted values are shown in Table D-2.

TABLE D-2. COMPARISON OF ACTUAL AND PREDICTED DAMAGES

Area	Reach	Index Stage (Feet, Msl)	Actual Damage ($1,000) Struc.	Actual Damage ($1,000) Cont.	Predicted Damage ($1,000) Struc.	Predicted Damage ($1,000) Cont.
Annex I	2	6.25			7.0	13.2
(Basin 3)	3	6.5			6.3	11.6
	4	6.75			7.7	15.2
		SUBTOTAL	24.0	51.5	21.0	40.0
Annex II						
(Basin 3)	3	6.5			.0	.0
	4	6.75			5.1	7.7
	5	7.0			5.8	10.1
		SUBTOTAL	13.8	4.1	10.9	17.8
Puntan Mutchot	1	5.75				
(Basin 3)						
		SUBTOTAL	21.0	69.8	28.0	74.2
		TOTAL	58.8	125.4	59.9	132.0

The unexplainable low content value loss in Annex II accounts for the major part of the discrepancy in actual versus predicted damages. The derived percent damage curves are comparable to values suggested by the 1975 revised Flood Insurance Administration (FIA) damage curves for one-story structures without basements.

Commercial and public percent damage curves were based on two sources. The structure portion developed for residences was used since the many small commercial buildings are built to the specifications of houses. Commercial and public building contents percent damage curves were based on those utilized by POD for similar types of establishments elsewhere. Sufficient commercial losses were not experienced in the August 1978 flood to present a good statistical basis for developing new curves.

Structure and Content Values. The predominant type of structure in Garapan is a concrete block house built on a slab. There are a few older wooden homes using post and beam foundations. Values (see table D-3) for different building types were obtained from the Mariana Islands Housing Authority for individual blocks in the study area. Content values were based on linear regression relationships between content and structure value developed from sample data for similar homes in comparable communities elsewhere in POD. This data covers the range of structure values encountered in Garapan. Commercial and public structure values were based on $38 to $40 per square foot for large buildings and $22 per square foot for small buildings. Content values were based on comparable establishments in similar communities elsewhere in POD, scaled down to reflect smaller inventories in Saipan.

TABLE D-3. BUILDING TYPE AND STRUCTURE VALUES

Basin	Reach	Building Type	Structure Value Range
3	1	Concrete	$24,300 - $27,000
		Wood on Post & Beam	$14,400 - $19,000
	2-5	Concrete	$24,300 - $36,000
2 (North of Island Power Road)	1-2	Concrete	$24,300 - $27,000
		Wood on Slab	$19,000
	3-6	Concrete	$24,300 - $27,000
		Wood on Post & Beam	$14,000 - $19,000
		Wood on Slab	$11,000
2 (South of Island Power Road)	2-5	Concrete	$30,000
		Wood on Post & Beam	$3,000
		Wood on Slab	$11,000

Damage and Benefit Categories. Flood damages occur to residential, commercial, and public properties. In addition to property damage, flood disasters necessitate large expenditures by relief agencies such as the American Red Cross. Private and public utilities and roads are frequently damaged. Benefits are based on inundation damage preventation and emergency relief cost saving with alternatives.

Damages. In computing estimated damages to existing developments, water surface elevations and the floodplain area were first determined for various flood magnitude by reach. Water surface elevation by reach and the exceedence probability is shown in table 5. The estimated damages for each development by depth of flooding were determined by correlating the floor elevation and the depth percent damage curve to value of structure and content. Stage damage information was prepared for residential, commercial, and public property using the derived percent damage curves. The calculations were made using the POD urban damage computer program (URBDAM). Stage damage data are tabulated in table D-4. The range of elevations is relatively small because the stages do not increase very much over the probability range of flood events.

Average Annual Damages. The frequency data in table D-5 and the damage data for residential, commercial, and public property in table D-4 were intergrated by URBDAM computer program to derive average annual damages. Average annual damages thus computed totaled $236,000, and are summarized by reach in table D-7.

Emergency Costs. Emergency costs were based on analysis of operations during the past flood. They include expenditure for Territory emergency crews, Red Cross relief work, Territory and Federal investigating teams, police, and rescue crews. The August 1978 flood resulted in the expenditure of $212,500 for relief basically by the American Red Cross. This total is the amount for the entire island; actually some 645 households were served. Roughly 82 residents in the Garapan area reported losses. Emergency relief cost savings were based on $330 per unit (in 1980 dollars). Average annual cost was

TABLE D-4. STAGE DAMAGE DATA

Basin (B) & Reach (R)	Elev. Msl.	Number Buildings	Accum. Buildings	Struc. Damage	Content Damage	Accum. Damage	Misc. Damage	Total Damage
B2 - R1	7	8	8	0.	0.	0.	0.	0.
	7.5		4	9912.0	11448.3	21360.3	3417.7	24778.0
	8	1	9	19824.	22897.	42721.	6835.	49556.
B2 - R2	7	10	10	0.	0.	0.	0.	0.
	7.5		5	9040.0	10369.5	19409.5	3105.5	22515.0
	8	0	10	18080.	20739.	38819.	6211.	45030.
B2 - R3	7	30	30	0.	0.	0.	0.	0.
	7.5		21	17972.0	22657.8	40629.8	6500.8	47130.5
	8	12	42	35944.	45316.	81260.	13002.	94261.
B2 - R4	7	38	38	0.	0.	0.	0.	0.
	7.5		26	24248.0	32425.0	56673.0	9067.7	65740.6
	8	15	53	48496.	64850.	113346.	18135.	131481.
	8.5		53	101692.0	107688.7	209380.7	33500.9	242881.7
	9	1	54	154888.	150528.	305416.	48866.	354282.
B2 - R5	6	5	5	0.	0.	0.	0.	0.
	6.5		14	1280.0	4236.8	5516.8	882.7	6399.5
	7	24	29	2560.	8474.	11034.	1765.	12799.
	7.5		36	16280.0	35519.4	51799.4	8287.9	60087.3
	8	14	43	30000.	62565.	92565.	14810.	10737.6
	8.5		47	61360.0	103607.6	1694967.6	26394.8	191362.4
	9	9	52	92720.	144650.	237370.	37979.	275349.

TABLE D-4. STAGE DAMAGE DATA (Contd)

Basin (B) & Reach (R)	Elev. Msl.	Number Buildings	Accum. Buildings	Struc. Damage	Content Damage	Accum. Damage	Misc. Damage	Total Damage
B2 - R6	7	1	1	0.	0.	0.	0.	0.
	7.5		0	220.0	815.4	1035.4	165.7	1201.0
	8	0	1	440.	1631.	2071.	331.	2402.
	8.5		2	880.0	2387.8	3267.8	522.9	3790.7
	9	3	4	1320.	3145.	4465.	714.	5179.
	9.5		7	2410.0	6553.5	8963.5	1434.7	10397.7
	10	6	10	3500.	9962.	13462.	2154.	15616.
B3 - R1	5	55	55	0.	0.	0.	0.	0.
	5.5		29	19280.0	51075.6	70355.6	11256.9	816125.
	6	4	59	38560.	102151.	140711.	22514.	163225.
	6.5		64	79620.0	154446.5	234066.5	37450.6	271517.2
	7	10	69	120680.	206742.	327422.	52388.	379809.
B3 - R2	5	4	4	0.	0.	0.	0.	0.
	5.5		6	2000.0	4257.1	6257.1	1001.1	7258.3
	6	9	13	4000.	8514.	12514.	2002.	14517.
	6.5		22	12540.0	23426.9	35966.9	5754.7	41721.6
	7	18	31	21080.	38339.	59419.	9507.	68927.
	7.5		31	41140.0	70003.5	111143.5	17783.0	128926.5
	8	1	32	61200.	101668.	162868.	26059.	188926.

TABLE D-4. STAGE DAMAGE DATA (Contd)

Basin (B) & Reach (R)	Elev. Msl.	Number Buildings	Accum. Buildings	Struc. Damage	Content Damage	Accum. Damage	Misc. Damage	Total Damage
B3 - R3	5	2	2	0.	0.	0.	0.	0.
	5.5		4	1000.0	2128.6	3128.6	500.6	3629.1
	6	7	9	2000.	4257.	6257.	1001.	7258.
	6.5		12	7500.	13683.6	21183.6	3389.4	24573.0
	7	6	15	13000.	23110.	36110.	5778.	41888.
	7.5		19	25820.	39867.7	65687.7	10510.0	76197.7
	8	8	23	38640.	56625.	95265.	15242.	110508.
B3 - R4	5	1	1	0.	0.	0.	0.	0.
	5.5		6	720.0	1259.9	1979.9	316.8	2296.6
	6	12	13	1440.	2520.	3960.	634.	4593.
	6.5		14	9960.0	17421.1	27381.1	4381.0	31762.0
	7	3	16	18480.	32322.	50802.	8128.	58931.
	7.5		20	35880.0	50202.5	86082.5	13773.2	99855.7
	8	8	24	53280.	68083.	121363.	19418.	140781.
B3 - R5	6	6	6	0.	0.	0.	0.	0.
	6.5		5	4320.0	6749.3	11069.3	1771.1	12840.4
	7	5	11	8640.	13499.	22139.	3542.	25681.
	7.5		12	20880.0	27072.2	47952.2	7672.4	55624.6
	8	2	13	33120.	40646.	73766.	11803.	85568.
	8.5		13	48240.0	58089.2	106329.2	17012.7	123341.9
	9	0	13	63360.	75533.	138893.	22223.	161115.

TABLE D-5. BASIN STAGE - EXCEEDENCE PROBABILITY DATA
(STAGES ARE IN FEET, MSL)

BASIN 2

REACH 1		REACH 2		REACH 3	
STAGE	PROBABILITY	STAGE	PROBABILITY	STAGE	PROBABILITY
3.090	0.6667	4.520	0.6667	5.050	0.6667
4.790	0.5000	5.300	0.5000	6.000	0.5000
5.790	0.1000	6.490	0.1000	7.340	0.1000
6.120	0.0500	6.890	0.0500	7.400	0.0500
6.470	0.0333	6.910	0.0333	7.460	0.0333
6.620	0.0200	6.990	0.0200	7.520	0.0200
6.690	0.0100	7.170	0.0100	7.590	0.0100
6.720	0.0050	7.240	0.0050	7.680	0.0050
6.720	0.0020	7.380	0.0020	7.800	0.0020

REACH 4		REACH 5		REACH 6	
STAGE	PROBABILITY	STAGE	PROBABILITY	STAGE	PROBABILITY
5.510	0.6667	6.080	0.6667	6.800	0.6667
7.300	0.5000	7.400	0.5000	8.520	0.5000
7.710	0.1000	7.810	0.1000	8.670	0.1000
7.870	0.0500	7.980	0.0500	8.780	0.0500
7.950	0.0333	8.070	0.0333	8.810	0.0333
8.040	0.0200	8.170	0.0200	8.860	0.0200
8.180	0.0100	8.320	0.0100	8.900	0.0100
8.300	0.0050	8.470	0.0050	8.980	0.0050
8.480	0.0020	8.680	0.0020	9.070	0.0020

TABLE D-5. BASIN STAGE - EXCEEDENCE PROBABILITY DATA (Contd)
(STAGES ARE IN FEET, MSL)

BASIN 3

REACH 1		REACH 2		REACH 3	
STAGE	PROBABILITY	STAGE	PROBABILITY	STAGE	PROBABILITY
4.710	0.6667	4.730	0.6667	5.940	0.6667
5.190	0.5000	5.290	0.5000	6.310	0.5000
5.640	0.1000	5.800	0.1000	6.650	0.1000
5.820	0.0500	5.990	0.0500	6.790	0.0500
5.910	0.0333	6.090	0.0333	6.870	0.0333
6.030	0.0200	6.210	0.0200	6.990	0.0200
6.200	0.0100	6.390	0.0100	7.160	0.0100
6.380	0.0050	6.580	0.0050	7.340	0.0050
6.580	0.0020	6.820	0.0020	7.600	0.0020

REACH 4		REACH 5	
STAGE	PROBABILITY	STAGE	PROBABILITY
6.170	0.6667	6.180	0.6667
6.690	0.5000	6.750	0.5000
7.080	0.1000	7.170	0.1000
7.230	0.0500	7.340	0.0500
7.320	0.0333	7.440	0.0333
7.450	0.0200	7.580	0.0200
7.630	0.0100	7.780	0.0100
7.820	0.0050	7.980	0.0050
8.120	0.0020	8.320	0.0020

computed using urban damage computer program and utilizing stage-probability data from table D-5 and number of buildings in table D-4 with at least 1 foot of flooding over first floor. Emergency relief cost data are shown in table D-6. Average annual emergency relief cost benefit is shown in table D-7.

TABLE D-6. EMERGENCY RELIEF COST DATA

Basin-Reach	Stage (Ft, Msl)	Number Residences	Accum Residences	Damage1/ ($1,000)
2-1	7	6	6	0
	8	1	7	2.3
2-2	7	6	6	0
	8	0	6	2.0
2-3	7	28	28	0
	8	15	43	9.2
2-4	7	30	30	0
	8	10	40	9.9
	9	1	41	13.2
2-5	6	5	5	0
	7	21	26	1.6
	8	6	32	8.6
	9	9	41	10.6
2-6	7	1	1	0
	8	0	1	.3
	9	3	4	.3
	10	6	10	1.3

1/ Computed as follows:

Accumulated residences w/ 1 foot of flooding x $330/unit.

TABLE D-6. EMERGENCY RELIEF COST DATA (Contd)

Basin-Reach	Stage (Ft, Msl)	Number Residences	Accum Residences	Damage1/ ($1,000)
3-1	5	53	53	0
	6	4	57	17.5
	7	9	66	18.8
3-2	5	4	4	0
	6	5	9	1.3
	7	4	13	3.0
	8	0	13	4.3
3-3	5	2	2	0
	6	5	7	.7
	7	8	15	2.3
	8	8	23	5.0
3-4	5	1	1	0
	6	11	12	.3
	7	3	15	4.0
	8	4	19	5.0
3-5	6	4	4	0
	7	0	4	1.3
	8	0	4	1.3
	9	0	4	1.3

1/ Computed as follows:

Accumulated residences w/ 1 foot of flooding x $330/unit.

TABLE D-7. AVERAGE ANNUAL DAMAGES

Basin (B) & Reach (R)	Residential Commercial & Public Damage ($)	Emergency Relief Cost ($)
B2 - R1	0	0
B2 - R2	438	22
B2 - R3	9,496	843
B2 - R4	39,299	2,797
B2 - R5	42,032	3,026
B2 - R6	2,231	186
B3 - R1	50,622	4,860
B3 - R2	5,921	416
B3 - R3	18,028	1,073
B3 - R4	43,839	2,413
B3 - R5	24,372	773
TOTAL	$236,278	$16,405

Average Annual Flood Reduction Benefits (Existing Development)

Average annual damages computed under improved conditions for the several alternatives are:

Alternative #1	$7,000
Alternative #2	$7,000
Alternative #3	$7,000

The difference in average annual damage without improvement and with improvements for the several alternatives is the benefits from damage prevention and summarized in table D-8.

TABLE D-8. AVERAGE ANNUAL FLOOD REDUCTION BENEFITS BY ALTERNATIVE

Category	Alternative 1	Alternative 2	Alternative 3
Damage without Improvement Residential, Commercial, Public	$236,000	$236,000	$236,000
With Improvement	7,000	7,000	7,000
Net Average Annual Benefits	$229,000	$229,000	$229,000

Business and Financial Losses. Benefits from prevention of business and financial losses are not expected to accrue from the project. Increased business activity outside the floodplain limits would offset any losses that may occur to flooded commercial enterprises.

Affluence Factor. In computing flood damages to existing development, the future increase in damageable property must be considered to reflect fair treatment of what damages would occur. This was done by increasing the estimated value of the contents of the residential structures at a rate that per capita income is expected to grow. There is no per capita income projection series for Saipan. However, the lowest estimated per capita income series developed for Guam by POD is believed applicable in terms of rate of growth. This series is shown in table D-9. At this rate of growth, the value of contents for the average Garapan residence would grow to 75 percent of structure value (the maximum growth for which benefits are allowed) by 2024 is also shown in table D-9. Total average annual damages prevented resulting from the application of the affluence factor methodology to existing residential development is $10,000.

TABLE D-9. PROJECTED PER CAPITA INCOME AND CONTENTS VALUE

Year	Per Capita Income 1/	Content Value
1980	$3,000	
1982	3,300*	$4,812
1990	4,600	
2000	6,100	
2010	7,700	
2020	9,900	
2024	11,000*	16,000
2030	13,200	
2032	13,900*	

* Interpolated or extrapolated
1/ In 1967 dollars

NED Employment Benefits (EDA). The 1973 Census indicated Saipan had a 9.2 percent overall unemployment rate. No later data are available. However, due to the continuing migration into the District Centers, generally, in the islands of the Trust Territory and former Trust Territory, it is likely that the rate has increased since 1973. Employment during construction benefits (EDA Benefits) are claimed for this project. Employment benefits were computed in accordance with Part IX of the U.S. Water Resources Council final rule dated 14 December 1979. The construction labor cost is split between skilled and unskilled labor. Thirty percent of the skilled and 47 percent of the unskilled costs are claimed as benefits. The average annual EDA benefits discounted on the basis of a 50-year period of analysis at 7-1/8 percent is $5,000 for Alternatives 1, 2 and 3.

Intangible Benefits. Intangible benefits accrued from the proposed project are reduction of health hazards associated with floods, and the improved morale of residents of the floodplain as a result of the reduction of flood damages and threat of life and limb.

Summary of Benefits. The average annual benefits from alternative improvements presented are summarized in table D-10. The two key economic measures utilized for project justification are the net benefits and the benefit-to-cost ratio (BCR). The net benefit is the difference between the average annual flood control benefits (potential losses in absence of the project) and the average annual costs. The difference between the two values must be positive for economic feasibility. In addition, the plan with the highest value is designated as the alternative which contributes most to the NED objective. Another measure utilized in comparing plans is the BCR, which is the ratio between the average annual benefits to the average annual costs. The NED plan may not necessarily be the plan with the highest BCR.

TABLE D-10. SUMMARY OF BENEFIT

Category	Average Annual Alternative 1	Alternative 2	Alternative 3
Flood Reduction Benefit Residential, Commercial, Public	$229,000	$229,000	$229,000
Affluence Factor	10,000	10,000	10,000
Emergency Relief Savings	16,000	16,000	16,000
NED Employment Benefits	5,000	5,000	5,000
Total Average Annual Benefit	$260,000	$260,000	$260,000
Total Average Annual Cost	241,000	255,000	277,000
Net Benefits	19,000	5,000	17,000
Benefit/Cost Ratio	1.08	1.02	0.94

GARAPAN FLOOD CONTROL
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SOCIAL AND CULTURAL RESOURCES

APPENDIX E

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SOCIAL AND CULTURAL RESOURCES

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APPENDIX E

SOCIAL AND CULTURAL RESOURCES

SOCIAL WELL-BEING

CULTURE AND HISTORY.

1. Saipan was originally inhabited by Chamorros. They were relocated to Guam by the Spanish in 1660. Under Spanish rule, the Chamorro population and culture were nearly obliterated. The decline of the Chamorro population was further influenced by intermarriage with the Spanish, Mexican and Filipino, who were present in the islands. Surviving Chamorros resettled on Saipan in the 1800's. However, the native population was a mixed race with a culture and tradition reflecting Spanish colonial influence. They were Catholic, trained in agriculture and their matrilineal system replaced with a patrilineal one, although their extended family ties persisted. Being poor and having no mineral wealth, Saipan and its people attracted little attention from the outside world. The native population consisted of subsistence farmers living in village establishments supplementing their farming with inshore fishing. In the 1800's, several hundred Carolinians established separate villages on Saipan. Their culture was not unlike the old Chamorro culture, but their language and culture set them apart from the native population.

2. Following the Spanish-American War, Germany administered the island, establishing public schools, extending the road network, and organizing an agricultural economy based on copra. However, the Japanese dominated trade in the region and after World War I obtained control of the island. By 1930, the total population on Saipan was about 45,000 of which less than 10 percent were native (Chamorro and Carolinian). Koreans and Okinawans were imported to supplement Japanese labor. Japanese school was mandatory for all on the island. Garapan became the center of population and economy under Japanese administration. Following World War II, all the surviving Japanese on Saipan were expatriated to Japan. The native population previously confined to Chalan Kanoa were allowed to circulate freely and by 1947 subsistence agriculture replaced the previously thriving sugar economy. The native population had to adapt to a new language, a new form of government and new cultural values. Saipan remained under US Navy administration until 1962 when it became part of the Marianas District, Trust Territory of the Pacific Islands, a trusteeship of the United Nations administered by the United States. Saipan became the headquarters for the Trust Territory of the Pacific Islands, a factor enhancing the presence of other Micronesian cultures on Saipan. In 1978, Saipan and 15 other islands in the Marianas District entered into a convenant with the United States forming the Commonwealth of the Northern Mariana Islands, a status separate from the Trust Territory of the Pacific Islands with closer association with the United States.

DEMOGRAPHY.

3. Of the three major islands in the Commonwealth, Saipan is the center of population, commerce, and government. The 1978 Commonwealth population was estimated at 14,850 (see Table E-1). The birth rate and death rate have remained relatively constant between 1972 and 1977. On the whole, the population is rather young and the ratio of males to females is relatively even.

TABLE E-1

DEMOGRAPHY OF THE NORTHERN MARIANAS

1. Geographical Features 1/

Islands	Area (sq mi)	1973 Population	Population Density per Sq Mi
Saipan	47	12,366	265
Rota	33	1,104	35
Tinian	39	714	20

2. Population by age group and sex (mid-year estimate, 1978) 2/

Age Group	Population	Male	Female
0-14	6,810	3,490	3,320
15-64	7,580	3,790	3,790
65+	460	220	240
Total	14,850	7,500	7,350

1/ Bulletin of Statistics, Trust Territory of the Pacific Islands, Office of Planning and Statistics, December 1978, Vol I,(3):p.11.

2/ Socioeconomic Development Plan for the Northern Mariana Islands, 1978-1995, Office of Transition Studies and Planning, by Robert Nathan Associates, Inc., October 1977, p.54.

COMMUNITY COHESION.

4. The estimated population of Saipan is about 12,400 (Office of Planning and Statistics, 1978). Chamorro, Carolinian, and Micronesian cultures constitute about 84 percent of the total population on Saipan. Tourism averages 700 persons per day and accounts for some of the island population. The proportion of natives in the total population declined from 92 percent in 1967 to 87 percent in 1973. Projections suggest that the native population may comprise 78 percent of the total population by 1985 (Physical Development Master Plan, 1978). The number of tourists visiting Saipan may increase to about 1,800 visitors per day by 1985. The majority of tourists visiting Saipan are from Japan while the second largest number comes from the United States. The distinctions between the Chamorro and early Carolinian cultures have faded, and the resident population has a strong identification by family groups and island community. Present cultural and ethnic views between residents and alien laborers, Americans, Japanese, and Micronesians are unknown.

EMPLOYMENT, EARNINGS, AND EXPENDITURES.

5. The total resident work force in the Commonwealth in 1976 was about 6,500 persons (Office of Planning and Statistics, 1978). About 43 percent of the work force were employed in the money economy (jobs in the western sense) and about 4 percent were employed in the village economy (subsistence economy) (Robert R. Nathan Associates, Inc., 1977). However, the total number of persons employed in the Commonwealth was about 7,000 of which 27 percent were

considered expatriates and 5,300 listed as Micronesian (Office of Planning and Statistics, 1978), which included the Trust Territory Headquarters employees. The data were insufficient to determine the ethnicity of the Micronesian group. Of the remaining resident work force, 19 percent were in school and about 34 percent were not in the labor market. More Micronesians hold lower paying jobs ($10,000 or less per year) than expatriates and more expatriates hold high paying jobs ($15,000 or more per year) than Micronesians. About 56 percent of those employed earned less than $10,000 per year. Government employed about 50 percent of the working force. Tourism (services) and wholesaling accounted for 68 percent of the employment and wages in private industry. Tourism is expected to be a significant economic force in the near future, but the government hopes to diversify economic growth. Manufacturing and handicrafts accounted for about 3 percent of the employment and wages earned in the Commonwealth in 1976 (Robert R. Nathan Associates, Inc., 1977). Essentially all materials and consumer items in the Commonwealth were imported. Excluding oil products, total reported imports in FY 1976 were $12.5 million, equivalent to $750 per capita. Food imports were equivalent to $280 per capita. The total number of taxpayers in the Commonwealth in Fiscal Year 1976 was 6,200 persons and the number is expected to decrease with the application of US Tax Laws. Under US tax rules, approximately 70 percent of the taxable wage earners would not have to file a tax return and another 20 percent would be entitled to a refund (Robert Nathan and Associates, Inc., 1977).

LAND USE AND DEVELOPMENTAL PATTERNS.

6. Prior to World War II, Saipan was essentially an agricultural colony of Japan where 30,000 acres were cultivated with over 18,000 acres cultivated in sugarcane. The population was centered around Garapan, which became a boom town. During World War II, Japanese agricultural fields and sugar mills were destroyed and replaced by a huge military complex of warehouses, airfields, military encampments, and munition storage areas. The local population were relocated from Garapan to Chalan Kanoa, which remains the most populous area in the Northern Mariana Islands and can be considered the government and economic center of the Commonwealth. Today, most of Saipan's 46 square miles of land area is relatively unused. A few hundred acres are cultivated, but the most productive area of marketable products is the 50-60 acre plot at the Kagman Agricultural Experiment Station (Pacific Planning and Design Consultants, 1978). Approximately 1,150 acres is used for grazing. Primary agricultural lands are located in the Kagman and Kobler Airfield areas at Saipan. Pasturelands for grazing and subsistence farming are located in the hills of Saipan.

7. An 11-mile area along the western coast of Saipan from Susupe to San Roque contains the bulk of the population on Saipan. The Chalan Kanoa, Susupe, San Jose and San Antonio villages in the southern area of Saipan contains 45 percent of the native population on Saipan. The central part of the coast includes the village of Garapan. The island's only port facilities and concentration of industrial development are located at Garapan in the Tanapag Harbor area. The Garapan area contains about 24 percent of the island population. The villages of Tanapag, San Roque, Capital Hill and Navy Hill rely upon Garapan for needed services; these areas contain about 16 percent of the island population.

8. The Garapan area is experiencing more rapid residential and population growth than any other village on Saipan. The Garapan Estates and two Sugar

King Developments are expected to more than double the area's population. Two of Saipan's most modern hotels and the best beaches are located in Garapan. Tanapag Harbor is located north of the residential area and is the primary port and industrial area on Saipan. The Physical Development Master Plan for Saipan (Pacific Planning and Design Consultants, 1978) assumes that Garapan will remain a desireable location for new residential growth because of the availability of easily developable land. The community master plan provides for a resort-tourist industry, memorial park, historical park, port and industrial facilities, a fishing village, new junior high and elementary schools, and a new hospital. The plans call for residential growth around the junior high school and east of the school site.

LAND OWNERSHIP.

9. In the Commonwealth society, landownership is closely tied with family solidarity and a sense of group responsibility and participation. Among some people, especially those of Carolinian descent, it is considered a solemn duty to retain land within the family. Thus, people are reluctant to sell land and the desire to own land is said to have resulted in a relatively high market valuation of land (Physical Development Master Plan, 1978). On the other hand, some segments of the population especially some of Chamorro descent, view land as an economic commodity to be bought or sold in the market place for monetary gain. Historical changes in land law systems (Spanish, German, Japanese and American) have created extremely complex and often contradictory sets of land records. Many conflicts and much confusion regarding property ownership exist, and many titles to private parcels are in dispute. Under German and Japanese rule, the government took over all land not enclosed or cultivated, a practice which prevented the accumulation of large private estates. Approximately 40 to 50 percent of the land on Saipan is privately owned and the remainder is publicly owned.

POWER.

10. Historically, only the government has been in a position to produce and distribute electrical power in the Northern Mariana Islands. The power system suffers from poor maintenance, deteriorating hardware and equipment, and frequent and prolonged outages of the primary power source. The system is dependent upon oil and costs are expected to increase with rising world oil costs. Energy conservation practices are not in effect and the growth of electrical demand is expected to be significant.

11. The primary source of power production on Saipan is the power barge "Impedance," commissioned in 1943, on loan from the US Army Corps of Engineers at no cost to the Commonwealth. The Impedance has the capability of generating 30 megawatts (MW) of power, but suffers from frequent and prolonged outages due to poor maintenance and deterioration. A standby power plant consisting of four diesel generators has the capability of supplying 7.4 MW and can be expanded with the addition of two small generators to 10 MW capacity. Emergency power generating equipment include seven small generators with a combined capability of 4.4 MW. Present power usage is about 11.2 MW. Power distribution is dependent upon 72 miles of primary lines (13.8 KVA) and 96 miles of secondary line. Two primary lines pass through the Garapan and serve the area south of the power barge. The lines carry 80 percent of the system load to the southern area of Saipan. The Physical Development Master Plan for Saipan estimated that power demands will increase to 23 MW by 1985 resulting

from the commercial, residential and industrial growth of Saipan envisioned in the plan. The master plan proposed construction of a new power plant consisting of several 7.5 or 10 MW diesel generators which would be capable of producing 20 MW of electrical power by 1985. A new power plant, which will replace the power barge "Impedance", is presently being constructed near the seaplane ramps in Tanapag Harbor.

WATER SUPPLY.

12. The water supply system suffers from deterioration, inadequate supply and conservation, poor water quality, and inadequate water pressure. The problems have resulted in poor fire protection, construction of private rainwater collection systems and periodic closing of water supply system to replenish water reservoir storage.

13. Major sources of groundwater on Saipan are basal well fields, high level aquifers lying above sea level and water reservoirs. The principal basal water areas include the Isley-Kobler field area and the Rapugau District. The most important high level groundwater resources are found at Agag and include Donni and Tanapag Springs. New well exploration has been concentrated in the Tanapag, Rapugau, Agag and Chacha areas on Saipan. The groundwater has high chlorides, hardness and total solids content requiring water softening treatment. Two treatment plants are located at Isley and Maui IV. However, these plants are not functioning properly due to the low capacity of the filters. The Physical Development Master Plan indicated that the filters must be backwashed every two days to be effective. Water salinity is controlled by reducing pumping of existing wells and dilution with water from the reservoirs. Most households have resorted to using cisterns to privately collect rainwater for drinking and cooking. In order to replenish water storage reservoirs, water supply valves are periodically closed, which introduces air into the water lines increasing rusting in the lines.

14. Total water production on Saipan varies from 2 to 2.4 million gallons per day (mgd). Based on a population of 14,000 and a daily production rate of 2.4 mgd, total water consumption per capita is 171 gallons per day. Metered homes consumed an average of 480 gallons per day. However, many homes are not metered and significant leakages and losses in the system most likely occur.

15. For an average family of five, the average rate of water consumption is 95 gallons per person per day. The Physical Development Master Plan estimated that by 1985 water requirements will average about 3 mgd including urban and industrial uses. Water demands in the Garapan area by 1985 are estimated at 2 mgd. To meet future water demands the existing water supply system servicing the Garapan area will supplemented by the addition of a 0.5 million gallon reservoir at San Roque.

16. The Garapan area is serviced by the Central Coastal and Navy Hill water system. The system includes five basal wells in the Rapugau District, four reservoirs and two springs. The reservoir system has a total capacity of 1.7 million gallons. The wells have a total pump capacity of 240 gallons per minute, and the springs have a capacity of about 250 gallons per minute. Two emergency reservoirs having a capacity of 12 million gallons are located at Tanapag. The Garapan area is serviced by a 6-inch line. Major improvements to the distribution system servicing north and south Garapan were proposed in the Physical Development Master Plan.

SANITARY SEWERAGE.

17. Parts of the Saipan sewerage system were constructd by the United States during World War II. Many areas are still using cesspools and septic tanks which are showing some indications of failure. The Garapan area is serviced by the Central Highland and Coastal Sewer System which includes North Garapan, Tanapag, the Navy and Capitol Hill, the hotels and Garapan Elementary School. The South Garapan area still uses private cesspools and septic tanks. The central sewer system collects and conveys wastewater to a primary treatment plant in the Rapugau District where the treated effluent is discharged into Tanapag Harbor. The treatment plant has a design capacity of 0.3 mgd with provisions to expand to 0.6 mgd and employs a Door Clarigester. The treatment includes primary sedimentation, digestion of settled solids, and chlorination. Project wastewater flows by 1985 in the Central Highland and Coastal area is estimated at 2.0 mgd of which 50 percent will be attributable to a 250-acre industrial area in Tanapag. The Physical Master Development Plan proposed the construction of a new treatment plant in Northern Tanapag or in the South San Roque area.

SOLID WASTES.

18. The present solid waste collection and disposal system on Saipan was judged inadequate in the Physical Development Master Plan. There is no organized refuse collection service for the majority of the residences on Saipan. Wastes are hauled to a dump at Puerto Rico in Garapan or to many numerous unauthorized areas. The Puerto Rico dump is a shoreline fill operation. Hazardous wastes are not handled with any standard procedure. Burning at private residences is not uncommon. Regular solid waste collection is provided at government housing areas, and public institutions, such as schools, hospitals and government offices. The Physical Development Master Plan estimates that there was about 12,190 tons of refuse (146,280 cubic yards) in 1978. The estimate was based on about 4 pounds of refuse generated per day per capita with an increase of 0.5 pounds per day per capita per year. By 1985, estimated refuse generated on Saipan could be 18,843 tons (225,116 cubic yards). The Physical Development Plan recommended that the existing dump in Garapan at Puerto Rico be closed and investigations be initiated in operating sanitary landfills at the Isley Kagman and San Roque areas.

HIGHWAY TRANSPORTATION.

19. The existing road system on Saipan originates from two sources: (1) the network of roads constructed by the Japanese prior to World War II and (2) the network of roads constructed by American Armed Forces shortly after 1944. Thus, most of the paved roads are over 30 years old and have deteriorated due to the absence of a regular maintenance program. In 1976, there were about 4,200 vehicles on the island. The number of private vehicles in 1976 was about 3,775, doubling the number registered in 1974. While traffic moves rather freely on the road system, significant traffic congestion occurs along the Beach Road in Chalan Kanoa. The Beach Road is the only road which provides continuous access to Tanapag Harbor, the Garapan area and the government housing areas from the population and government center at Susupe-Chalan Kanoa. The West Coast Highway provides the fastest and most direct route from southern Saipan to Tanapag.

MEDICAL CARE.

20. Health services in the Commonwealth are provided by the government and are organized into essentially four divisions: hospitals and dispensaries, public health, dental services, and environmental health and sanitation services. Major health service facilities are located on Saipan. Rota and Tinian have primary and emergency care facilities. The outer islands are provided health services through outpatient care, monthly visitations by a medical team and village nurse concept. The adequacy of the facilities in comparison to the U.S. is poor and the ratio of medical staff to population is low (0.56 physician to 1,000 population, 0.13 registered nurses to 1,000 population). Commonwealth residents are charged lower rates than non-residents, but costs are very low for all patients. Heart disease and malignant neoplasm are leading causes of death with accidents, diabetes, cerebral vascular accidents and pneumonia following in frequency.

POLICE PROTECTION.

21. Crime is on the increase in the Commonwealth and is expected to continue to grow as a problem in relationship to the growth of the tourist industry. The police force, criminal retention, and justice system was judged to be inadequate. Felonies increased 13 percent and misdemeanors increased by 8 percent between 1974 and 1976. The police force consists of 47 officers on Saipan, 5 officers on Tinian and 7 officers on Rota. Criminal retention facilities are located in the police station at the Saipan Civic Center. Escape from the retention facility is not uncommon. There are no criminal counseling or vocational programs for rehabilitation. On an average there are usually 12-15 adults and 5-7 juvenile adults in the retention facilities.

FIRE PROTECTION.

22. Fires in the Commonwealth are on the increase and the fire protection system was also judged to be inadequate. The Fire Department is located at the Civic Center in Susupe. In Fiscal Year 1976 the Fire Department responded to 227 calls, an increase from 157 in Fiscal Year 1975. Response time within the Susupe-Chalan Kanoa area is 5-8 minutes. Although there are 108 fire hydrants on Saipan, the hydrants are useless at night because the water system is shut down at night to conserve water. The staff of the Fire Department consists of 15 firemen on Saipan and 1 on Rota. The police on Rota and Tinian double as firefighters. The firefighters at the Civic Center also provide fire protection at the airport when flights are scheduled. The fire equipment at the Civic Center include one pumper and one nurse truck. Another pumper was to be purchased in Fiscal Year 1978.

TROPICAL STORMS/TYPHOONS.

23. The Commonwealth did not have a disaster preparedness plan as of October 1977. Typhoons are a constant threat to life and property as a result of high winds and flooding due to heavy rainfall and high seas. The Mariana Islands lie within an area where tropical storms develop into typhoons. At least 19 typhoons occur annually across the western North Pacific and South China Sea. Several of these typhoons in various stages of development threaten the Mariana Islands annually. During a 28-year period (1948-1975) 70 tropical storms and typhoons were tracked within 180 nautical miles of Guam (120 miles south of Saipan). Twenty-six (26) of these were full strength typhoons. Based on the

period of record, there is greater likelihood of a developing typhoon threatening the Mariana Islands during all months of the year. The majority of typhoons occur during the rainy season from August through November with the peak activity occurring in October and November. A secondary peak of activity also occurs in April and May. One typhoon a year affects the Mariana Islands. However, the character of typhoon frequency is irregular. No typhoons occurred in 11 years of the 28-year period, although tropical storms occurred. Of the typhoons that affected the Mariana Islands, all originated in the Truk-Kwajalein area of the Trust Territories. These storms travel westward from the Truk-Kwajalein area toward the Mariana Islands, where they generally approach the Mariana Islands from the south and southeast quadrant. Nine typhoons significantly affecting the Mariana Islands are listed on Table E-2. Record of damages from the Commonwealth are incomplete.

TABLE E-2

TYPHOONS SIGNIFICANTLY AFFECTING THE MARIANA ISLANDS, 1948-1976

Date	Name	Remarks
November 1949	Typhoon Allyn	Eye passed 60 nautical miles south of Guam. Wind gusts over 100 knots. Several injuries, no deaths. No damage reports from Commonwealth area available.
November 1957	Typhoon Lola	Eye passed 40 nautical miles south of Agana. Wind gusts over 100 knots. No damage reports from Commonwealth area available.
November 1962	Typhoon Karen	Eye passes over Guam. Wind gusts 150-160 knots. No damage reports from Commonwealth area available.
April 1963	Typhoon Olive	Eye passed 35 nautical miles south of Agana. Wind gusts 85-90 knots. Damages on Saipan: $4.4 million, 95% of all homes destroyed and all utilities inoperative.
December 1963	Typhoon Susan	Eye passed 70 nautical miles north of Agana. Wind gusts of 70 knots. Damages in Commonwealth: 25%-90% of homes on Rota, Tinian and Saipan damaged.
November 1967	Typhoon Gilda	Eye passed over Rota. Wind gusts 60 knots. Damages on Rota: 100 buildings destroyed, 500 homeless, 8 injuries, no deaths.

April 1968	Typhoon Jean	Eye passed 95 nautical miles north of Agana. Wind gusts on Saipan 140-150 knots. Damages on Saipan: $16 million, thousands homeless, 90% of homes destroyed, no injury and no deaths.
November 1975	Typhoon June	Eye passed 215 nautical miles west-southwest of Guam. Wind gusts 70 knots. No damage reports from Commonwealth available.
May 1976	Typhoon Pamela	Eye passed over Guam. Wind gusts over 100 knots for 18 hours. No damage report from Commonwealth area.

CULTURAL RESOURCES

PREHISTORIC PERIOD.

24. Based on comparative dates and settlements on nearby Guam, Saipan was probably occupied as early as 1500 B.C., although no firm dates yet exist for Saipan. Most evidence of prehistoric settlement exists today at inland locations, many of which it has been hypothesized were once prehistoric coastal environments. The places along historic shorelines have undergone severe modification by the Japanese and Americans between 1930 and 1945. The shoreline consists of fill material and/or concrete. Thus, the likelihood of finding any prehistoric (archaeological) sites in flat coastal areas is negligible. No prehistoric archaeological sites on Saipan Island are currently eligible for or listed on the National Register of Historic Places.

HISTORIC PERIOD.

25. The Mariana Islands were discovered by Magellan in 1521, but no detailed information became available until after 1668, when the first Spanish mission began on the Island of Guam. In the later 18th century, all natives were reportedly removed from the Northern Marianas in order to assure the primacy of Guam as a rest and refitting station for the Manila Galleon trade route. Permanent resettlement of the Island of Saipan did not occur until 1842 with the arrival of Carolinians and subsequently, Chamorro colonists. For 15 years between 1899 and 1914, Saipan was under German control, but the initial modernization of the island came under the Japanese from 1914 to 1944. Garapan and Chalan Kanoa became the island's major population centers, the island was intensively cultivated, primarily in sugarcane, and tens of thousands of Japanese permanently colonized the islands. Among the surviving Japanese structures, two are listed on the National Register of Historic Places; the Japanese Hospital and the Japanese Lighthouse, both in the vicinity of Garapan. Two memorials to the Japanese defense of the island also are listed: Banzai Cliff and Suicide Cliff, both in northern part of the island. The Sugar King Historic Park is planned to include the Japanese Hospital, jail, sugar train and the Sugar King Monument.

26. Two cultural resource reconnaissance studies, one conducted by the Corps of Engineers and one by the National Park Service, identified historic features in the American Memorial Park and a prehistoric midden site along the West Coast Highway. Both surveys utilized the services of the Pacific Studies Institute. The National Park Service survey identified eight historic sites in the park as eligible for inclusion to the National Register of Historic Places. The sites consist of Japanese fortifications storage tanks and barracks and bathhouse. A Japanese pillbox and bunker are located in the outlet channel area, but not within the channel easement. The Corps of Engineers survey identified a prehistoric midden site in the diversion channel alignment. The site may be eligible for listing on the National Register of Historic Places as it may contain scientific data that could be used in developing an understanding of prehistoric settlement and use of coastal resources on the west coast of Saipan. The midden recovered from the site consisted of pottery sherds and shells unearthed by sewer construction along the highway alignment. The construction of the sewerline may have destroyed a portion or all of the site, and the construction of a proposed waterline through the same area may destroy the remaining portion of the site, if any.

No archaeological sites were found in the Hafa Adai Hotel outlet channel alignment. No surveys were conducted of the Garapan Elementary School outlet channel alignment. However, based on the results of the Hafa Adai Hotel channel alignment, no historic and archaeological sites are anticipated due to the highly modified nature of the area. Much of the area was destroyed and modified during World War II and the post-war era.

GARAPAN FLOOD CONTROL
SAIPAN, CNMI

PUBLIC INVOLVEMENT

APPENDIX F

APPENDIX F

PUBLIC INVOLVEMENT APPENDIX

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PUBLIC INVOLVEMENT APPENDIX

PUBLIC INVOLVEMENT PROGRAM

1. The public, as broadly interpreted by the US Army Corps of Engineers, is any affected or interested non-Corps of Engineers entity which includes other federal and local government agencies, public and private organizations, and individuals. The public participation program is directed to maintaining the information flow, achieving a mutual understanding and acceptance of the problems and needs, and attaining the interest level necessary for proper decisionmaking.

2. The objectives of the public participation program for this study are:

a. To inform the public of the current Corps of Engineers planning process.

b. To surface key planning issues and concerns so that they are given full consideration.

c. To help formulate and assess potential plans of improvement.

d. To offer technical, historical, and localized information pertinent to the study.

3. The US Army Corps of Engineers, Honolulu District, has the responsibility for conducting the study. The study is being coordinated with the Coastal Resources Management Office, CNMI, who is serving as the local coordinating agency.

4. The public involvement program has consisted of study notification and coordination meetings with key governmental agencies and officials, and a public workshop to obtain public input on identifying problems, needs and possible solutions to the flooding problem in Garapan. After this draft report is circulated to federal and local agencies and interested individuals, a public meeting will be held to obtain the public's views on the alternative plans of improvement. Public views and concerns expressed at this meeting and during the report review period will be incorporated into the final report, and a second public meeting will be held to present the final selected plan.

SUMMARY OF PUBLIC WORKSHOP

5. Government of Northern Marianas agencies and officials were notified in January 1979 of the initiation of detailed studies for the flood problem at Garapan. An informal workshop was conducted on 21 March 1979 at Marianas High School. It was attended by interested citizens and goverment representatives (Table F-1). Local TV coverage was also provided. The following concerns were expressed at the meeting:

a. Flooding due to Tropical Storm Carmen in August 1978 was the worst flooding in the memory of many Garapan citizens.

b. Flooding in Garapan can be attributed to:

(1) General gradient of the basin slopes toward the MIHA developments of Annex I, Annex II, and Puntan Muchot (Figure 5 of the Main Report).

(2) The present flood control measures in Garapan consist of ponding basins. These basins, which are designed to control interior discharge only, are flooded by basin runoff and often overflow, causing inundation of nearby homes.

(3) The Garapan area, below West Coast Highway, is very flat which results in a limited conveyance of runoff to the ocean. This condition, along with the lack of drainage channels, causes serious ponding problems in lowlying areas. According to longtime residents, drainage channels once existed in Garapan. However, these channels were obliterated by development.

c. According to MIHA authorities, flooding is an annual occurrence in Garapan.

d. Siltation of offshore areas should be minimized or controlled as much as possible.

TABLE F-1

Attendance at Public Workshop
21 March 1979

Federal, Corps of Engineers

Mr. Russell Takara, Project Engineer
Mr. Mitsuo Waki, Hydraulic Engineer
Mr. David Dang, Economist
Mr. Edward Yoshimura, Hydraulic Engineer
Mr. Ronald Pang, Estimator

Federal, Others

Mr. Otto Van Der Brug, US Geological Survey, Guam
Mr. Dan A. Davis, US Geological Survey, Honolulu

Government of Northern Mariana Islands

Mr. M. Obradovitch, Department of Public Works, CNMI
Mr. Alfred Pangelinan, Department of Public Works, CNMI
Mr. Pete A. Tenorio, Executive Director, Marianas Public Land Corp.
Mr. Lorenzo L.G. Cabrera, Executive Director, Mariana Islands Housing Authority

Ms. Martha McCart, Coastal Zone Manager, CNMI
Mr. George Chan, Environmental Protection Agency, CNMI

Government of the Trust Territory of the Pacific Islands

Mr. Mike Gawel, Planning Office, TTPI

Individuals

Ms. Margarit Reyes
Mr. Frank T. Rogones
Mr. Pedro Sasamoto
Mr. Malcolm F. Stiles
Mr. Ben Taguchi
Mr. James Tamura
Mr. Joaquin A. Tenorio

DRAFT REPORT AND ENVIRONMENTAL STATEMENT REVIEW

6. The draft document was sent to the following agencies for review:

a. U.S. Government Agencies

Advisory Council on Historic Preservation, Washington and Denver Offices

Department of Commerce

Deputy Assistant Secretary for Environmental Affairs
Regional Representative
Coastal Zone Management, Pacific Region
National Marine Fisheries Service
National Oceanic & Atmospheric Administration, SW Region

Environmental Protection Agency

Regional IX, EIS Coordinator
Officer of Field Activities

Department of Health, Education and Welfare

Regional Administrator

Department of Housing and Urban Development

Assistant Secretary for Community Planning and Management
Regional Administrator
Honolulu Area Office

Department of the Interior

Office of Environmental Project Review
Interagency Archaeological Services
Fish and Wildlife Service, Portland and Honolulu Offices
National Park Service, San Francisco and Honolulu Offices
Geological Survey

Department of Transportation

Commander, 14th Coast Guard District
Federal Highway Adminitration

b. <u>Commonwealth</u>

Office of the Governor
Department of Public Works
Mariana Islands Housing Authority (MIHA)
Commonwealth Historic Preservation Officer
Department of Natural Resources
Officer of Planning and Budget
Mayor of Saipan
Division of Marine Resources Development
Division of Environmental Quality
Office of Coastal Resources Management
Marianas Public Land Corporation
Department of Public Health

Garapan Flood Control
Saipan, CNMI

RECREATION AND NATURAL RESOURCES

Appendix G

APPENDIX G

RECREATION AND NATURAL RESOURCES

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RECREATION AND NATURAL RESOURCES

RECREATION

1. Recreation problems and needs have been previously reported in the Northern Mariana Islands Park and Outdoor Recreation Resource Study (April 1977) and the Physical Development Master Plan for the Commonwealth of the Northern Mariana Islands, Volume II, Saipan (January 1978). The studies indicate that a multitude of recreational facilities already exist on Saipan and that there is a need to improve or renovate the facilities. These facilities include 13 basketball courts, two public tennis courts, five public little league baseball fields and quasi-public facilities associated with hotels and government housing areas. In the Garapan area, picnic facilities are located at Puntan Muchot, basketball courts are located at the International Hotel, a multipurpose field is located at the Garapan Elementary School, a boat ramp is located at the Garapan Dock and a historic park is located at the Sugar King Monument. The studies recommended development of recreational facilities for children of pre-school age, mini-parks, neighborhood playgrounds, and community playgrounds. The needs will be met by combining the recreational facilities with school and area center facilities. Plans for recreation development in the Garapan area include the development of a junior high school, the American Memorial Park which will serve as a regional park on Saipan, and expansion of the historic park centered around the Sugar King Monument, Japanese sugar train, hospital and jail (see Figure G-1). The development of a small boat harbor at Garapan Dock would serve commercial and recreational boating and fishing needs. Recreation facilities and resources are summarized below:

a. Scenic and Wild Rivers. None are present in the Garapan area.

b. National Trails. None are present in the Garapan area.

c. Natural Landmarks. None are present in the Garapan area.

d. National Shoreline, Parks or Beaches. The site of the proposed American Memorial Park is located just north of the Garapan. The park lands were set aside by the United States Government (133 acres) for public use as a memorial to the American and Marianas people who were killed or wounded in the Marianas campaign during World War II.

e. Water Contact Recreation. Pole and cast net fishing activities occur along the Garapan shoreline. Some recreational boats and skin diving tour boats operate out of the American Memorial Park area. A boat launching ramp is also located at the Garapan dock area. Micro Beach and Beach Drive Park provide passive recreation areas for swimming and bathing. The US Fish and Wildlife Service (1979) indicated that a surfing site is located outside the lagoon barrier reef at the Garapan entrance channel mouth, but a reference for the source of information is not available.

NATURAL RESOURCES

GEOLOGY.

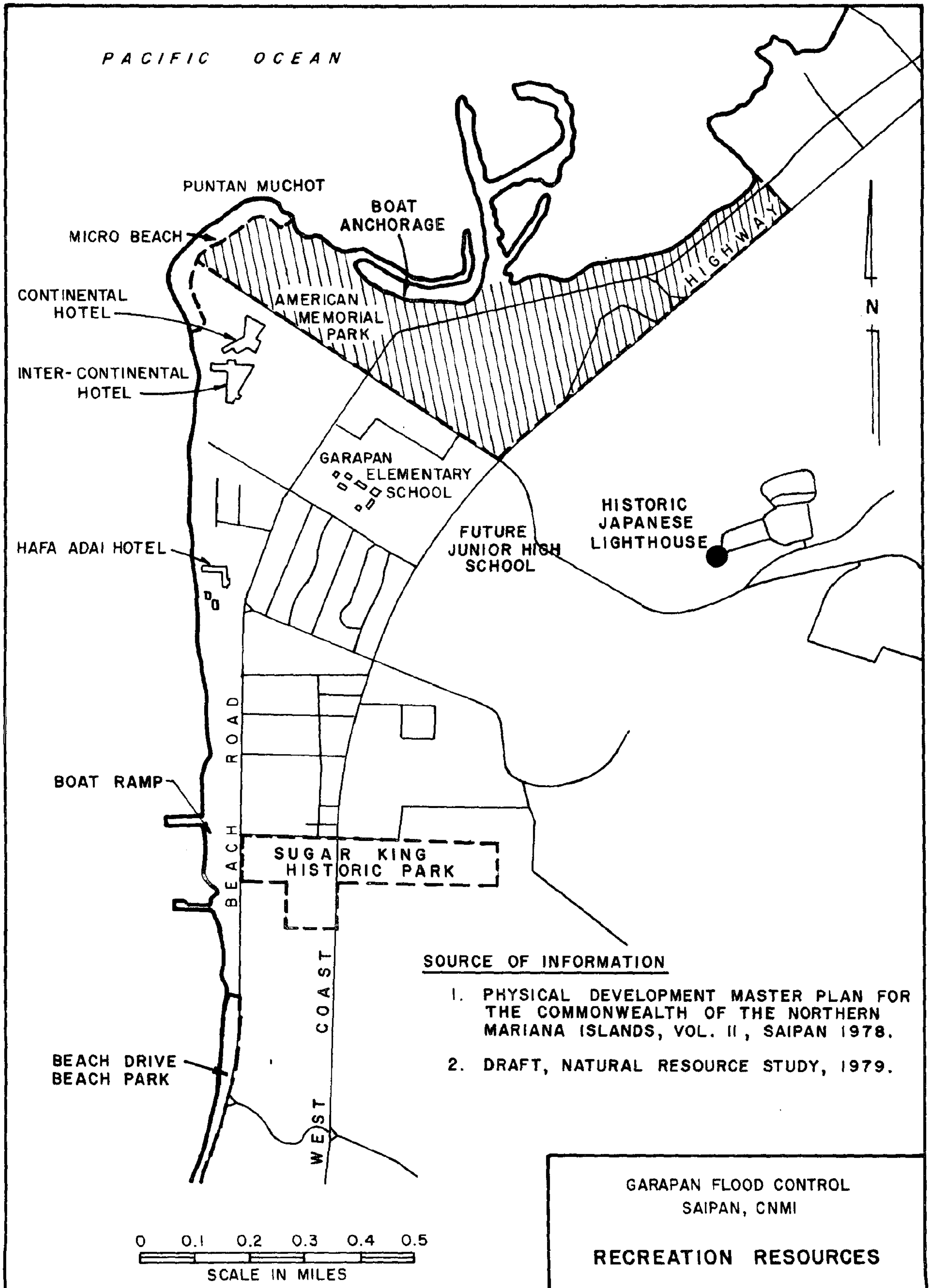
2. The Garapan area is located on the west coastal plain of Saipan. The plain is composed of beach sand, coralline sand-rubble fill and clay overlying limestone. Puntan Muchot is a sandy point. The Garapan and American Memorial Park areas consist of filled land. Saipan Lagoon is a high-island with barrier reef lagoon. The barrier reef lies approximately 3,000 feet offshore from the Garapan area.

VEGETATION.

3. Four generalized vegetation communities were briefly described by the US Fish and Wildlife Service (1979); a coastal strand, urban area, tangan-tangan community and forest community. The coastal strand community included beach morning glory, hibiscus, coconut, ironwood and various grasses and shrubs. The urban community included a mixture of plants from all other vegetation communities including a variety of garden vegetables and decorative shrubs. The tangan-tangan community consisted of pure stands of tangan-tangan and stands mixed with grasses and sword plants. Hibiscus, upland taro and pandanus were components of the tangan-tangan community in damper areas with deep soils. The forest community was dominated by a mixture of tall (20-75 feet) introduced food or ornamental trees together with pandanus bamboo, hau and ironwood. A list of 31 plant species was provided (Table G-1).

WETLANDS.

4. Two wetlands were located in the Garapan area. The smaller one (see Figure G-2) was about 250 meters in diameter bordered on three sides by roads and several ill-defined roads through it. Grasses dominated the vegetation and the presence of duckweek (Lemna minor) suggested that the wetland was permanently wet (Moore, et al; 1977). Twelve species were found to be common in the wetland, and elephant grass (Pennisetum purpureum), California grass (Brachiara mutica) and guinea grass (Panicum maximum) were abundant in the wetland (Table G-2). Juan C. Tenorio and Associates, Inc. put the location of the wetland closer to the Navy Hill Road and the Coastal Highway, which divides the wetland into two parts. The second wetland is located in the American Memorial Park area and is about 200 meters in diameter. The area was once part of an airfield and is crossed by eroded, overgrown asphalt roads. The area was and is probably still being used as a dump by the local population. The area is poorly drained and marshy, and the fill and asphalt from the air strip probably made the area a convenient catchment basin. Grasses dominated the vegetation in the wetland. Fifteen plant species were listed as common (Table G-2), and the elephant, California and Guinea grasses were again dominant. Hibiscus (Hibiscus tiliaceus) and tangan-tangan were also common around the wetland. The ironwood tree (Casuarina equisetifilia) dominates the overstory. Both wetlands have freshwater, probably as a result of ponding stormwater, and are probably present due to alterations in the surrounding areas. The National Park Service indicated that the Unai Sadog Tase shoreline in the American Memorial Park is dominated by mangrove. Thus, the area could also be classified as a wetland.



GARAPAN FLOOD CONTROL
SAIPAN, CNMI

RECREATION RESOURCES

U.S. ARMY ENGINEER, DISTRICT, HONOLULU

FIGURE G-1

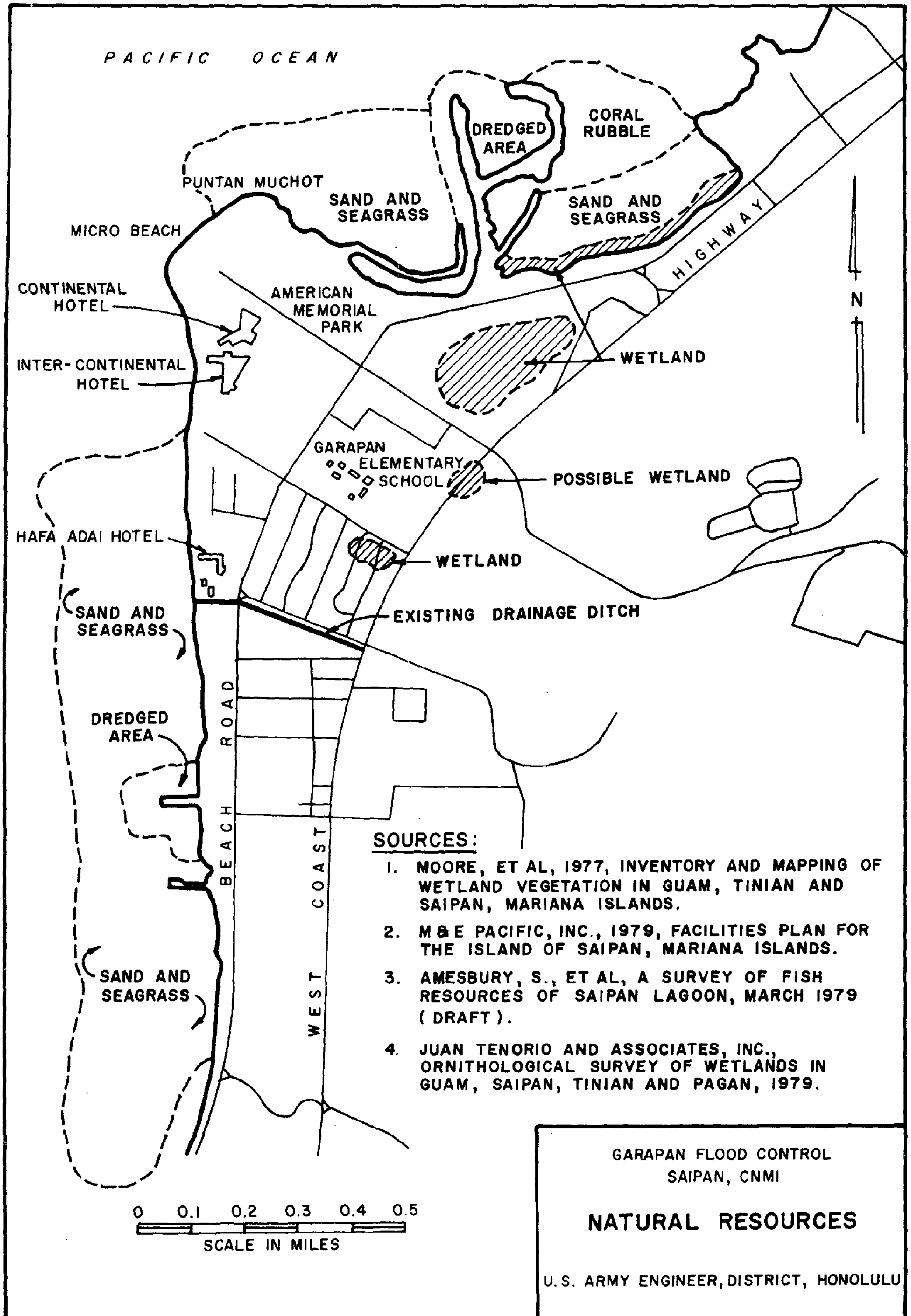

PACIFIC OCEAN
PUNTAN MUCHOT
DREDGED AREA
CORAL RUBBLE
SAND AND SEAGRASS
SAND AND SEAGRASS
MICRO BEACH
HIGHWAY
N
CONTINENTAL HOTEL
AMERICAN MEMORIAL PARK
INTER-CONTINENTAL HOTEL
WETLAND
GARAPAN ELEMENTARY SCHOOL
POSSIBLE WETLAND
HAFA ADAI HOTEL
WETLAND
SAND AND SEAGRASS
EXISTING DRAINAGE DITCH
DREDGED AREA
BEACH ROAD
WEST COAST
SAND AND SEAGRASS
SOURCES:
1. MOORE, ET AL, 1977, INVENTORY AND MAPPING OF WETLAND VEGETATION IN GUAM, TINIAN AND SAIPAN, MARIANA ISLANDS.
2. M & E PACIFIC, INC., 1979, FACILITIES PLAN FOR THE ISLAND OF SAIPAN, MARIANA ISLANDS.
3. AMESBURY, S., ET AL, A SURVEY OF FISH RESOURCES OF SAIPAN LAGOON, MARCH 1979 (DRAFT).
4. JUAN TENORIO AND ASSOCIATES, INC., ORNITHOLOGICAL SURVEY OF WETLANDS IN GUAM, SAIPAN, TINIAN AND PAGAN, 1979.
0 0.1 0.2 0.3 0.4 0.5
SCALE IN MILES
GARAPAN FLOOD CONTROL
SAIPAN, CNMI
NATURAL RESOURCES
U. S. ARMY ENGINEER, DISTRICT, HONOLULU

FIGURE G-2

TABLE G-1. DOMINANT PLANTS IN THE GARAPAN DRAINAGE

Reported by US Fish and Wildlife Service Biologist, 1979

COMMON NAME	SCIENTIFIC NAME
TREES	
Kapok Tree	Ceiba pentandra
African Tulip Tree	Spathodea campanulata
Ironwood	Casuarina equisetifolia
Tangan Tangan	Leucaena leucocophala
Papaya	Carica papaya
Breadfruit	Artocarpus incisus or mariannensis
Mango	Mangifera indica
Bamboo	Bambusa vulgaris
Banana	Musa sp.
Coconut	Cocos nucifera
Betel Nut	Areca cathecu
Acacia	Acacia confusa
Flame Tree	Delonix regia
Screw Pine	Pandanas tectorius
Nilo	Thespesia populnea
Hau	Hibiscus tiliaceus
	Pluchea indica
UNDERGROWTH	
Rat-tail Dropseed	Sporobolus elongatus
Lovegrass	Eragrostis tenella
Guinea Grass	Panicum maximum
Sword Grass	Miscanthus floridulus
Crowfoot Grass	Dactyloctenium aegyptium
Lagundi	Vitex trifolia
Sword Plant	Sansevieria trifasciata
Passion Fruit	Passiflora foetida var. hispida
Sedge	Cyperus odoratus
Candlebrush	Cassia alata
Coffee-Senna	C. occidentalis
Upland Taro	Alocasia macrorrhiza
False Verbena	Stachytarpheta indica
Beach Morning Glory	Ipomoea pes-caprae
Nigas	Pemphis acidula

SOURCE: US Fish and Wildlife Service, Planning Aid Letter, 27 September 1979.

TABLE G-2. A CHECKLIST OF WETLAND VEGETATION IN THE GARAPAN AREA

A = abundant   C = common   S = seldom   R = rare

Scientific Name	Common Name	Abundance Small Wetland	Abundance Large Wetland
MONOCOTYLEDONAE			
CYPERACEAE			
Cyperus brevifolius (Rottb.) Hasskarl		S	-
C. compressus L.		C	-
C. cyperinus (Retz.) Suringar		S/R	-
C. ligularis L.		C	-
C. odoratus L.		C	C
Fimbristylis cymosa R. Br.		C	-
GRAMINEAE			
Eleusine indica (L.) Gaertn.	Goose grass; Chaguan Kabayo	C	C
Panicum maximum		*	A
Pennisetum polystachion (L.) Schultes		-	S
P. purpureum Schumacher	Elephant grass	A	A
Phragmites karka (Retz) Trin. ex Steud.	Karriso	S	-
Brachiara mutica (Forsk.) Stapf		A	A
LEMNACEAE			
Lemna CF. minor L.	Duckweed	S	-
DICTYLEDONAE			
CASUARINACEAE			
Casuarina equisetifolia L.	Ironwood; Gago	C	C
COMPOSITAE			
Pulchea indica (L.) Less.		-	C
CUCURBITACEAE			
Momordica charantia L.	Bitter melon; Admagoso	C	-
LEGUMINOSAE			
Albizia lebbeck (L.) Bentham	Siris tree; Mamis	S	-
Cassia alata L.	Candlebush; Andadose; Akapulko	C	-
C. occidentalis L.	Mumutun-sable; Coffee-senna	C	C

*Text (Moore, 1977) indicates Panicum maximum was included in the dominant grasses.

TABLE G-2. A CHECKLIST OF WETLAND VEGETATION IN THE GARAPAN AREA

A = abundant C = common S = seldom R = rare

Scientific Name	Common Name	Abundance: Small Wetland	Abundance: Large Wetland
Desmanthus virgatus (l.) Willd.		C	C
Leucaena lecocephala (Lam.) deWit	Tangan-tangan	C	C
Mimosa pudica L.	Sleeping grass	-	C
Pithecellobium dulce (Roxb.) Bentham	Kamachile	-	C
Sesbania cannibina (Retz.) Persoon		S	C
ONAGRACEAE			
Ludwigia octivalvis (Jacq.) Raven	Titimo	-	C
MALVACEAE			
Hibiscus tiliaceus L.	Pago	-	C
Sida acuta Burm.	Escobilla Papago	S	-
S. rhombifolia L.	Escobilla Dalalai	S	-
PASSIFLORACEAE			
Passiflora foetida var. hispida (Triana & Planch.) Gleason	Love-in-a-mist; Kinahulo Adao	C	C
P. suberosa L.			
RUBIACEAE			
Morinda citrifolia L.	Lada; Indian Mulberry	-	C

SOURCE: Inventory and Mapping of Wetland Vegetation in Guam, Tinian and Saipan, Mariana Islands, Moore, P., et al, June 1977.

WILDLIFE.

5. Ten species of birds were observed in the urban and beach area of Garapan by the US Fish and Wildlife Service (1979), and ten species of birds were observed in the upper watershed (Table G-3). The avifauna was more diverse in the upper watershed than in the urban and beach areas. About 126 birds were seen in the upper watershed as compared to 107 birds observed in the urban and beach area. The eurasian tree sparrows were the most abundant species observed. Within the upper watershed, cardinal honeyeaters and eurasian tree sparrows were the most abundant birds observed. In the urban and beach area the cardinal honeyeater, eurasian tree sparrow, Philippine turtle dove and the bridled white-eye were the most abundant birds observed. Two US Fish and Wildlife Service biologists reported observing a Marianas crow in the upper watershed. This was the first report of the presence of the Marianas crow on Saipan, however, the sighting has not been confirmed.

6. Avifauna in two wetland areas were surveyed in 1979 (Juan Tenorio and Associates, Inc., 1979). Seventeen species of birds were observed. Six species were found in the smaller wetland and 12 species were found in the larger wetland. Only the Chinese least bittern was common to both wetlands. The ruddy turnstone and the Chinese least bittern were the most abundant birds in the smaller wetland. The Philippine turtle dove, gallinule, white tern, cardinal honeyeater and the bridled white-eye were the most frequently seen birds in the larger wetland.

MARINE RESOURCES.

7. A survey of fish resources in Saipan Lagoon was completed by Amesbury, et al (draft, 1979). The survey identified 24 fish habitats and 249 fish species in the lagoon. Twenty-two species of fish were identified as economically valuable fish, and their abundance and distribution in the lagoon were estimated. Equilibrium yields of exploitable fish were also estimated. The distribution of fish larvae and eggs was studied by analysis of plankton net tows. The marine flora and fauna and oceanographic and water quality characteristics of Tanapag Harbor were studied by Doty and Marsh (1977) for one year. The US Fish and Wildlife Service (1979) provided qualitative data on marine resources at the Garapan dock, American Memorial Park boat mooring area, North Tanapag Harbor and Chalan Kanoa sugar dock.

8. In the Garapan area, Amesbury identified two fish habitats at the outlet of the existing drainage ditch adjacent to the Hafa Adai Hotel. The inshore habitat (Amesbury: Habitat 2) consisted of a substrate of fine sand dominated by stands of seagrass, *Enhalus acroides*, sometimes mixed with other seagrasses and algae. Rabbitfish were found to be the most abundant fish in the habitat and goatfish and snappers were relatively abundant. Thirty-eight species of fish were associated with the habitat. The mid-lagoon habitat (Amesbury: Habitat 7) consisted of a sand and rubble substrate dominated by a mixture of algae which included *Padina*, *Caulerpa* and *Dictyota*. A moderate diversity of fishes occur in the habitat, but economically important fishes did not occur in high abundance. Fifty species of fish were associated with the habitat type. Plankton net tows at the Garapan Dock found a fish egg density of 10.5 individuals per cubic meter and a fish larvae density of less than one individual per cubic meter.

TABLE G-3. LIST OF AVIFAUNA OBSERVED IN GARAPAN AREA

Scientific Name	Common Name	Upper Watershed 1/	Observed Urban-Beach Area 1/	Small Wetland 2/	Large Wetland 2/
Myzomela cardinalis	Cardinal Honeyeater	50	17	-	17.5
Cleptornis marchei	Golden honeyeater	10	1	-	1.0
Paser montanus	Eurasian tree sparrow	30	51	-	5
Corvus kubaryi	Marianas Crow	1	-	-	-
Gygis alba	White tern	12	2	-	20
Gallicolumba xanthonura	White throated dove	1	-	-	-
Ptilinopus roseicapilla	Marianas fruit-dove	2	-	-	-
Streptopelia bitorquata	Philippine turtle dove	8	17	-	40
Halcyon chloris	Collared Kingfisher	4	-	-	2.5
Zosterops conspicillata	Bridled white-eye	8	13	-	57.5
Rhipidura rufifrons	Rufous-fronted fantail	-	1	-	42.5
Pluvialis dominica	Lesser Golden Plover	-	2	-	-
Numerius phaeopus	Whimbrel	-	2	-	-
Heteroscelus incanum	Wandering Tattler	-	1	5.8	-
Ixobrychus Sinensis	Bittern (Yellow, Chinese Least)	-	-	44.2	2.5
Acrocephalus luscinia luscinia	Nightingale Reed Warbler	-	-	-	10
	Reef Heron	-	-	2.5	-
	Ruddy Turnstone	-	-	22.5	-
	Micronesian starling	-	-	-	5
	Ground Dove	-	-	-	2.5
Gallinule chloropus	Marianas Gallinule	-	-	5.8	-
	Pacific Golden Plover	-	-	2.5	-
	TOTAL INDIVIDUALS	126	107		
	TOTAL SPECIES	10	10	6	12

1/ US Fish and Wildlife Service, 1979.
2/ Birds per 100 minutes of field contact, Juan Tenerio and Associates, Inc., 1979.

9. The US Fish and Wildlife Service (1979) provided a qualitative description of the marine ecosystem at the Garapan Dock. Their report identified three habitat types at the dock; a shoreline and rubble habitat, a dredged area habitat and a habitat similar to Amesbury's Habitat 2. The rubble along the edges of the dredged area were reported to be visited by schools of cardinal fish, juvenile squirrel fish, sweepers, damselfish, adult surgeonfish, rabbit-fish, snappers, goat fish, an occasional eel and a variety of gobies and blennies. Live coral coverage was estimated visually to be 5%. The bottom of the dredged dock basin was sandy and a variety of algae and sea grasses was estimated to cover 90% of the substrate. Fewer fish were seen and those present principally included a few snappers and schools of goat fish. The jellyfish, Cassiopea sp. was considered the predominant invertebrate. A unique habitat area was provided by the numerous wrecks in the area which provided habitat for a variety of fish and invertebrates.

10. In the American Memorial Park area facing Tanapag Harbor, Amesbury described three habitat types. These habitats included the inshore habitat previously described (Habitat 2), a dredged area habitat (Habitat 9) and coral rubble habitat (Habitat 4). The dredged area habitat was described as a silty rubble substrate littered with wreckage and some coral growth. The water was judged to be rather turbid, but the greatest number of high-bodied jacks were observed in this habitat. The jacks were small subadults swimming in schools. The coral rubble habitat was described as a habitat dominated by patches of Halodule and a diverse assemblage of Caulpera. The highest counts of silver-sides occurred in this habitat although their abundance was low. The US Fish and Wildlife Service described the environment inside the Memorial Park harbor which is not applicable to the impact area, although the species observed in the harbor may be present at the impact area.

11. Amesbury's studies were the most definitive for the project area. In comparison to the other habitats described, the habitats at the project sites were not found to have a high diversity of fish or high abundance of fish egg and larvae. However, the high densities of juvenile, economically important fish prompted him to recommend conservation of the habitats described.

ENDANGERED SPECIES.

12. No endangered or threatened species list for the Northern Mariana Islands has been developed. The Endangered Species Coordinator, US Fish and Wildlife Service indicated that the threatened green sea turtle has been seen in Saipan Lagoon. The status of ten birds and two mammals on Guam is being reviewed for possible nomination for inclusion to the Federal List of Endangered and Threatened Species. The status review on Guam does not necessarily reflect the status of the birds or mammals in the Northern Mariana Islands region. For reference, a list of birds and mammals being reviewed on Guam is provided in Table G-4. The nightingale reed warbler is listed as endangered on the Federal List of Endangered and Threatened Species in its range within the Trust Territory of the Pacific Islands.

MIGRATORY BIRDS, WILDLIFE REFUGES, AND MARINE SANCTUARIES.

13. Migratory shorebirds were observed by the US Fish and Wildlife Service (1979) in the beach-urban area of Garapan. No breeding or nesting areas were identified. No wildlife refuges or marine sanctuaries have been designated in the Garapan area.

TABLE G-4. LIST OF GUAMANIAN BIRDS AND MAMMALS BEING REVIEWED FOR POSSIBLE LISTING ON THE FEDERAL LIST OF ENDANGERED AND THREATENED SPECIES

Common Name	Scientific Name
Marianas Fruit Bat	*Pteropus mariannus mariannus*
Little Marianas Fruit Bat	*Pteropus tokudae*
Marianas Fruit Dove	*Ptilinopus roseicapillus*
Marianas Gallinule	*Gallinula chloropus guami*
Guam Rail	*Rallus owstoni*
Edible Nest Swiftlet	*Collocalia inexpectata bartschi*
Micronesian Kingfisher	*Halcyon cinnamomina cinnamomina*
Micronesian Broadbill	*Myiagra oceanica freycineti*
White-throated Ground Dove	*Gallicolumba xanthonura xanthonura*
Cardinal Honey-eater	*Myzomela cardinalis saffordi*
Marianas Crow	*Corvus kubaryi*
Bridled White Eye	*Zosterops conspicillata conspicillata*

SOURCE: Federal Register, 44(98): 29128-29130 (May 18, 1979).

GROUNDWATER AND COASTAL WATER QUALITY.

14. No water quality standards have been established for Saipan. Two water studies provide information on coastal water quality: (1) "Marine Survey of Tanapag, Saipan: The Power Barge "Impedance," Doty and Marsh, March 1977, and (2) Facilities Plan for the Island of Saipan, Mariana Islands, M&E Pacific, Inc., for the Department of Public Works, Government of the Northern Mariana Islands. The data are applicable to the Unai Sadog Tase and the Saipan Harbor channel and are presented in Table G-5. The Garapan wastewater treatment plant which serves the northern coast and central highlands of Saipan including the villages of Tanapag, Garapan, Puntan Mutchot and the Capital Hill and Navy Hill government housing areas discharges about 0.43 mgd of primary treated effluent into Tanapag Harbor. Infiltration is believed to account for 70-75% of the average daily flow into Tanapag Harbor. The power barge "Impedance" discharges about 29 mgd of thermal effluent into Tanapag Harbor at Baker Dock. The major non-point sources in the Garapan area are surface runoff from upland and urban areas, and possibly subsurface and surface discharges from cesspools and privies. Surface discharges from cesspools and privies occur during periods of intense rainfall, especially in the lower Garapan area. Floodwaters have caused cesspools and privies to overflow and carry the wastewaters into the lagoon. An intermittent drainage ditch in the Garapan area enters Saipan Lagoon near the Hafa Adai Hotel. There are no potable groundwater sources in the Garapan area.

TABLE G-5. WATER QUALITY MEASUREMENTS

Lagoon (Source: M&E Pacific, Inc., 1979)

Station	pH	Temp(^oC)	Salinity (0/00)	Turbidity (NTU)	D.O. (mg/1)	TKN (ug/1-N)	NO_3-N (ug/1)	Total P (ug/1)	Total Coliform (#/100ml)	Fecal Coliform (#100ml)	Chlorophyll-a mg/m^3
4 Top (T)	8.3	28.9	33.7	0.86	5.9	250	0.8	10	1	1	0.45
4 Bottom (B)	8.3	28.5	33.6	0.45	6.1	325	0.3	13	1	1	0.35
5T	8.2	28.8	33.7	0.65	6.2	378	0.5	36	1	1	0.34
5B	8.2	28.6	33.8	0.44	6.0	235	0.3	18	1	1	0.27
6T	8.2	28.7	33.4	0.67	6.1	304	0.6	24	20,000	20,000	0.59
6B	8.25	28.5	33.7	1.20	5.9	341	0.3	17	13	3	0.62
						NO_2	NO_3 ug-at/1		PO_4		
Unai Sadog Tase (Source: Doty and Marsh, 1977)											
6	-	26.8	33.3	-	7.46	0.07	0.17		0.11		
8	-	27.6	24.4	-	8.17	0.02	0.03		0.16		

GARAPAN FLOOD CONTROL

SAIPAN, CNMI

COMPLIANCE DOCUMENTS

APPENDIX H

APPENDIX H

COMPLIANCE DOCUMENTS

Title	Item No.
Section 404 Evaluation Report	I
U.S. Fish and Wildlife Service Planning Aid Letter	II

GARAPAN FLOOD CONTROL STUDY

EVALUATION OF THE EFFECTS OF THE DISCHARGE OF DREDGED OR FILL MATERIAL INTO WATERS OF THE UNITED STATES USING U.S. ENVIRONMENTAL PROTECTION SECTION 404(b) GUIDELINES

1. Project Description.

a. Description of the proposed discharge of dredged or fill material:

(1) General Characteristics of the Material. The material used to line the flood control channel will consist of 20-250-pound limestone rocks (riprap) and 3-inch or less limestone aggregate (bedding layer) which will also be used to construct a temporary dredge causeway. Concrete will be used to construct the culverts under the coastal highway and beach roads.

(2) Quantity of material proposed for discharge.

	Plan 1	Plan 2	Plan 3
Riprap	3,500 CY	3,800 CY	5,000 CY
Bedding Material	1,800 CY	2,500 CY	3,000 CY
Concrete	100 CY	250 CY	500 CY

A temporary dredge causeway needed for dredging the channel outlet in Saipan Lagoon will utilize approximately 1,600 CY of bedding material.

(3) Source of Material. The material will be quarried from Black Micro Quarry on Saipan.

b. Description of the proposed discharge site for the dredged or fill material:

(1) Location of the Discharge Site. Garapan, Saipan (see attached figure).

(2) Type of Discharge Site Involved. The fill material will be used to protect the outlet channel for the Garapan Flood Control project from erosion.

(3) Method of Discharge. The material will be placed in the channel banks by crane. The temporary fill will be placed by bulldozer and removed by crane and bucket.

(4) Date and Length of Time When Discharge Will Occur. The discharge will occur within 5 years of project approval, and it will take about 7 months to complete the outlet channel construction.

(5) Project Life of the Discharge Site. The flood control channel will have an estimated economic life of 50 years.

(6) Provide Bathymetry (if open water site): Not applicable.

2. Physical Effects . Potential Destruction of Wetlands - The discharge of the fill material would not involve the destruction of any wetland areas. Channel alignments associated with Plans 1 and 3 do not physically affect any wetlands in the Garapan areas. Plan 2 passes in close proximity to a wetland in the American Memorial Park and will require special construction methods to prevent the wetland from draining into the flood control channel. The diversion channel, a feature common to the three plans may involve work in a wetland area, which has not been clearly identified or located.

3. Chemical-Biological Interactive Effects.

a. The material proposed for discharge meets the criteria for exclusion from elutriate and bioassay testing. The fill material will consist predominantly of gravel or other naturally occurring material with particle sizes larger than silt.

b. Impacts on the Water Column:

(1) Reduction in Light Transmission. The placement of the bedding material and the temporary causeway will temporarily increase water turbidity since the material will contain some fine, limestone dust. Concrete and riprap placement will not increase water turbidity.

(2) Degradation of Water Aesthetics. The increase in water turbidity will temporarily degrade water aesthetics.

(3) Direct Destructive Effects on Nektonic and Planktonic Populations. No effect is anticipated because the fill is not expected to contain toxic substances.

(4) Presence of Contaminants in the Fill Material. The fill is not expected to contain any contaminants since it will be obtained from a quarry source.

(5) Concentration of Contaminants. Not applicable. The material meets criteria for exclusion from elutriate testing.

(6) Comparison of Constituent Concentrations with Applicable Water Quality Standards. Not applicable.

(7) Size of the Mixing Zone. Not applicable. Except for the temporary dredge causeway, all fill material will be confined to the discharge site.

c. Site Comparisons: Not applicable. All the alternative discharge sites consist of dredged channels extending from Saipan Lagoon to the Coast Highway. Contaminant content of the material proposed for discharge is not deemed critical to warrant selection of another discharge site.

4. Impacts of the Discharge at the Discharge Site.

a. Need for the proposed activity: The discharge is related to the construction of a flood control channel which is needed to reduce flood damages and losses in the Garapan area.

b. Availability of alternate discharge sites and methods of discharge: The alternative outlet channel alignments through the Garapan area are being considered. The construction of the channels using riprap material is similar for three alternative outlet channel alignments.

c. Description of the impacts on the following items:

(1) Chemical, Physical, and Biological Integrity of the Aquatic Ecosystem. No effect. The aquatic ecosystem will be man-made with the discharge created by excavating a channel on land. The fill material is inert and will not introduce any new pollutant discharges into the new aquatic ecosystem.

(2) Food Chain and Trophic Level. No effect.

(3) Diversity of Plant and Animal Species. The rocky habitat formed by the placement of the riprap will be colonized by organisms preferring solid substrates.

(4) Movement into and out of Feeding, Spawning, Breeding, and Nursery Areas . No effect.

(5) Wetlands that have Significant Functions on Water Quality Maintenance. No effect.

(6) Areas that Serve to Retain Natural High Waters or Flood Waters. The fill will not effect water storage capacity of the floodplain.

(7) Degradation of Water Quality. No long-term degradation anticipated as a result of the placement of the fill material.

d. Description of methods to minimize water turbidity:

(1) The channel will be constructed without connection to the ocean for the majority of its length. All the fill will be placed in a man-made channel and no turbid waters will be discharged into the lagoon during the majority of the construction period. This action will also allow any fine material, suspended in the water column, to settle out in the channel.

(2) The majority of the material to be placed in the water will consist of material larger than silt size and will not be easily eroded. In particular, the temporary dredge causeway will be constructed using bedding material and not fine sand.

(3) Any dewatering effluent will be discharged into a stilling basin to remove sediments prior to discharge into the lagoon.

e. Description of methods to minimize degradation of aesthetics, recreation, and economic values:

(1) The outlet channel is expected to increase recreational diversity and reduce flood damages and losses resulting in economic benefits to the floodplain residents.

(2) A foot bridge will be placed over the channel near the mouth of the channel to permit free pedestrian movement along the shoreline.

f. Other methods investigated to minimize possible harmful effects:

(1) Appropriate scientific literature developed by EPA.

(2) Consideration of alternatives to open water discharge, such as confined discharges.

(3) Use of disposal sites where physical environmental characteristics were amenable to the type of dispersion desired.

(4) Discharge beyond the baseline of the territorial seas.

(5) Covering any contaminated material with cleaner material.

(6) Conditions to minimize runoff from confined areas.

g. Impacts on the following items of water use:

(1) Municipal Water Supply Intakes. No effect.

(2) Shellfish. No adverse effect. The discharge increases habitat for potential use by shellfish.

(3) Fisheries. No effect. The channel may increase fish nursery, spawning and rearing habitat.

(4) Wildlife. No effect.

(5) Recreational Activities. No effect.

(6) Benthic Life. The fill creates new aquatic habitat for benthic life.

(7) Wetlands. No effect.

(8) Submersed Vegetation. No effect.

(9) Size of the Disposal Site. No effect.

(10) Coastal Zone Management Programs. No effect.

5. Determinations.

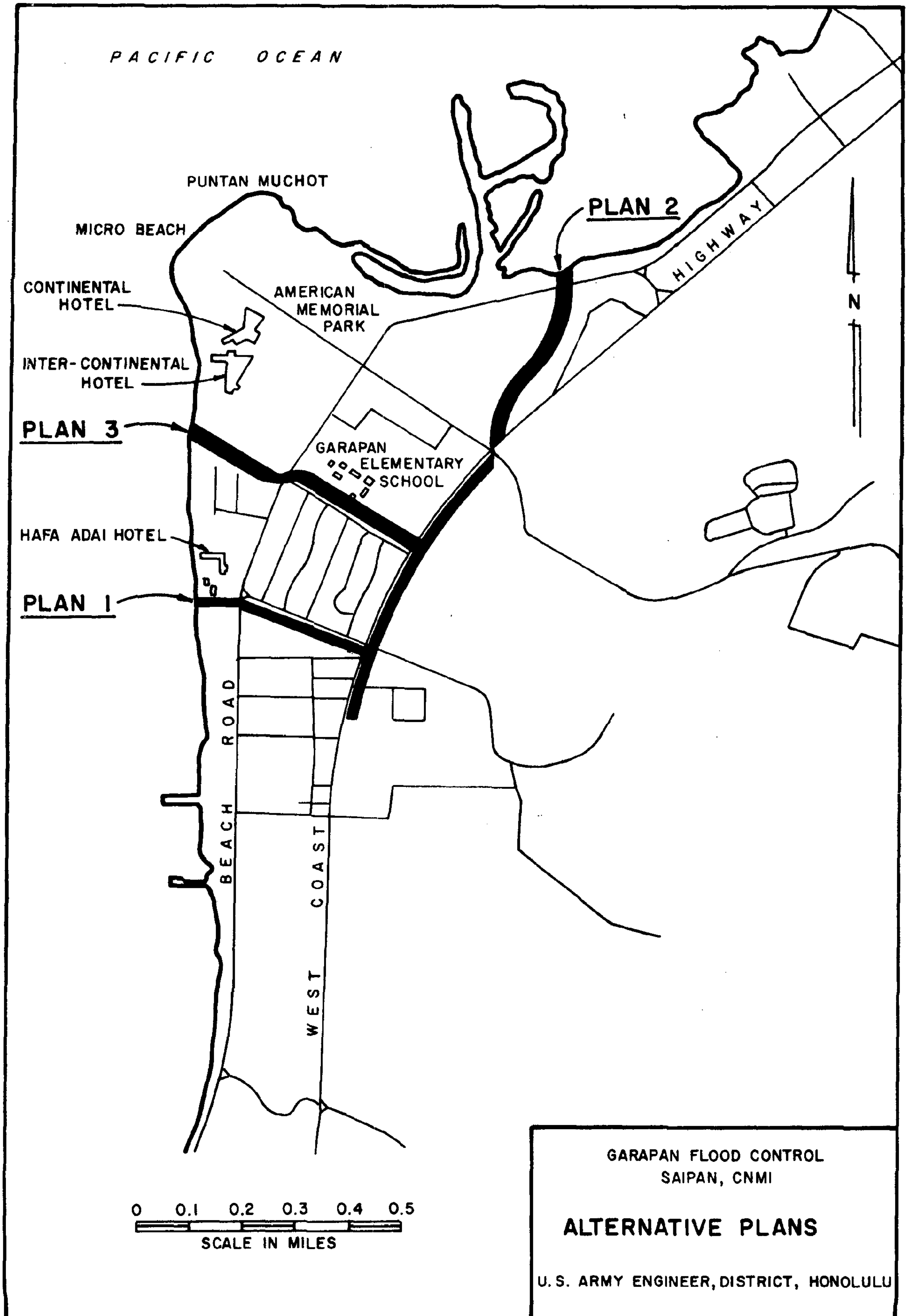
a. An ecological evaluation was made following the guidance in 40 CFR 230.4, in conjunction with the evaluation consideration of 40 CFR 230.5.

b. Appropriate measures were identified and incorporated in the proposed plan to minimize adverse effects on the aquatic environment as a result of the discharge.

c. Consideration was given to the need for the proposed activity, the availability of alternative sites and methods of discharge that are less damaging to the environment, and such water quality standards as appropriate and applicable by law.

d. Wetlands: In Plans 1 and 3, the proposed fill and the activity associated with it will not cause permanent unacceptable disruption of the beneficial water quality uses of the wetland ecosystem. Plan 2 requires that impermeable membranes or other methods be employed to prevent possible movement of water from a wetland in the American Memorial Park into the flood control channel.

6. Findings. The alternative discharge sites for the Garapan Flood Control study outlet channel is specified through the application of the Section 404 (b)(1) guidelines.


PACIFIC OCEAN
PUNTAN MUCHOT
MICRO BEACH
CONTINENTAL HOTEL
INTER-CONTINENTAL HOTEL
AMERICAN MEMORIAL PARK
PLAN 2
HIGHWAY
N
PLAN 3
GARAPAN ELEMENTARY SCHOOL
HAFA ADAI HOTEL
PLAN 1
BEACH ROAD
WEST COAST
0 0.1 0.2 0.3 0.4 0.5
SCALE IN MILES
GARAPAN FLOOD CONTROL
SAIPAN, CNMI
ALTERNATIVE PLANS
U.S. ARMY ENGINEER, DISTRICT, HONOLULU

United States Department of the Interior

FISH AND WILDLIFE SERVICE
300 ALA MOANA BOULEVARD
P. O. BOX 50167
HONOLULU, HAWAII 96850

ES IN REPLY REFER TO:
Room 6307

September 27, 1979

Lt. Col. B. R. Schlapak
U.S. Army Engineer District Honolulu
Building 230
Fort Shafter, Hawaii 96858

Re: Garapan Area Flood Control, Saipan, CNMI

Dear Sir:

This is the U.S. Fish and Wildlife Service's planning aid letter on the proposed U.S. Army Corps of Engineers' Garapan Area Flood Control Project, Saipan, Commonwealth of the Northern Mariana Islands. It has been prepared under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), however, it does not fulfill Section 2(b) of the Act. When final plans with alternatives have been received from the Corps, the Service will prepare a detailed report with recommendations for the protection, conservation, development, mitigation and/or compensation for project caused fish and wildlife resource losses. The project is being planned under Section 205 of the 1948 Flood Control Act, as amended.

This report is based on data gathered from existing published and unpublished documents, on Service field investigations on May 3-4, 1979 and files. Project engineering features were taken from the Corps Reconnaisance Report dated 24 November 1978.

Project Description

The Corp of Engineers Reconnaissance Report (Nov. 1978) indicates a tentative plan to build a 1,300-foot long by 20-feet wide, rectangular, concrete channel, a 5,000-foot long by 7-feet high earth levee and two, 20-foot clear span bridges at Garapan, Saipan (Fig. 1, 2). The levees will direct sheet flow into the channel which will convey it to the sea just south of the Garapan Dock area (Fig.2, Ref. 1). No estimate of channel depth is given.

Project Description Without The Project

The Commonwealth of the Northern Marianas is a group of fourteen islands located approximately 3,800 miles west of Hawaii. The island group runs north-south for a distance of about 440 miles and has a total land area of approximately 184 square miles. The island of Saipan is the largest in the group (Fig. 1). It is also the capital and center of population and commerce for the Commonwealth.

Saipan is approximately 13 miles long, four miles wide, with a total land area of 46.7 square miles.

Garapan Village is located on Saipan's west-central coast. Prior to its nearly complete distruction during World War II, it was the principle population center on Saipan. Extensive rebuilding was done after the U.S. invasion to facilitate administrative services and storage of war-related materials. Since the late 1940's, most of the U.S. military buildings have deteriorated or have been replaced by residential or light commercial buildings. Garapan is also the site of three major hotels. These are located along the white sand Micro Beach that borders a wide, shallow lagoon.

Aerial photographs (February 23, 1944, on file at U.S.G.S. Honolulu Office) indicate that most of the Japanese village was concentrated on a .8-mile wide coastal plain. This area has a lime-sand or artifical fill substrate. It may have been quite marshy at one time as evidenced by the small marsh that is present in an unfilled area along the northern edge of the village (Ref. 4). Inland from the village the land rapidly rises in a series of terraces that form Saipan's central limestone hill range. Mt. Tagpachau (1,555 feet), Saipan's highest elevation is about 2.5 miles southeast of the village. The slopes of this geologically complex, but principally Tagpachau limestone ridge, are dissected by steep ravines and occasional nearly vertical fault cliffs. The narrow ravines and areas along the cliffs appear to have been shrub or forest vegetation in 1944, while much of the remaining terraces were cleared and cultivated in what appears to be sugarcane. Aerial photographs from 1978 show little little evidence of farming along the slopes above Garapan.

There are no perennial streams within the project area. The deep valleys on the hillsides contain intermittant stream channels but there are no defined channels crossing the coastal plain. The watershed within the project area covers 1.9 square miles (Ref. 1).

Post World War II construction obliterated Japanese drainage ditches in Garapan and provided no replacements. Runoff as sheet flow, after heavy rains now moves overland toward the low lying urban areas and causes serious flood damage. A major flood that occurred in August 1978 resulted in Garapan and other areas in Saipan being declared a major disaster area (Ref.1). Flood problems in parts of Garapan are compounded by roads being elevated above the house lot levels and an inadequate urban drainage system.

Service field investigations involved a visual survey of the northern end of the drainage system. Lack of defined trails and a high density of wasps precluded extensive exploration of the upper watershed. An additional ground survey was done along the beach from Muchot Point to the Garapan Sugar Dock area.

Extrapolation of ground survey information to 1978 aerial photographs indicates that previously cleared areas in the watershed have revegetated with nearly pure stands of tangan-tangan (Leucaena leucocephala). The closed tangan-tangan canopy is 15-20 feet high and dense enough to inhibit extensive undergrowth in the more xeric hillside habitats. Ravines, however, have deeper soil that retains water better than the slopes. In these areas undergrowth is often highly developed with dense areas of grasses and sword plants. Hau, upland taro and pandanus are also important constituents of the damper tangan-tangan areas (Table 1).

The remaining forest vegetation is generally dominated by a 20-75 feet-high mixture of introduced food or ornamental trees along with pandanus, bamboo, hau and ironwood (Table 1).

The beach has typical strand vegetation including beach morning glory, hau, coconut, ironwood and various grasses and shrubs (Table 1).

Urban vegetation includes many of the above species, especially flame trees, and a variety of garden vegetables and decorative shrubs.

Few terrestrial animals other than birds, introduced land snails and domesticated farm species were observed within the watershed (Table 2). The upper watershed harbors a high (subjective judgment) population of birds (Table 3). Except for the Eurasian tree sparrow and the Philippine turtle dove, the avifauna is dominated by indigenous or endemic (to the Mariana Islands) species. Golden honeyeaters, endemic to Saipan, are common. Four species, Marianas crow, white-throated dove, Marianas fruit-dove and cardinal honeyeaters have been proposed for federal listing as Endangered Species in Guam, the most southern Mariana Island. The Marianas fruit bat which has also been proposed for Endangered status, may be present in this area but it was not observed (Ref. 5).

The environmentally disturbed urban areas of Garapan have a higher exotic component in the avifauna (Table 3). Philippine turtle-doves and Eurasian tree sparrows are much more common here than in the upper watershed. The proposed endangered bridled white-eye was the only resident native bird that increased in abundance within the urbanized areas. Three native migrant wading birds were seen along the beach and one additional native terrestrial bird, the rufous-fronted fantail was in a small grove of trees. Based upon the Shannon-Wiener Diversity Index and equitability quotient (=E) (Table 3), the upper watershed has a more diverse avifauna than the urban area. Greater vegetation stratification, higher topographical relief, decreased human disturbance and greater abundance of mature fruit trees on the slopes perhaps accounts for the difference in equitability and in the greater presence of native bird species.

A nearby swamp that was not closely surveyed because it was not within the proposed project boundaries should be mentioned here because of its proximity to the project. It lies just north of the project and east of the Japanese Small Boat Harbor. This area was an open water Phragmites - Scirpus dominated marsh before the U. S. invasion. Since the invasion, the marsh has been partially filled and has changed to a hibiscus - hau - tangan-tangan swamp with standing but not open water. Service biologists heard nightingale reed warblers and saw the Marianas gallinule in the marsh in May 1979. The reed warbler is classified as an endangered species and the gallinule is being proposed for endangered status (Ref. 5).

The nearshore marine environment is principally a sandy algae-seagrass habitat (Table 4) that is inhabitated by at least 32 species of fish and an unknown variety of invertebrates (Table 2, Ref. 6). There is little solid substrate near shore except for cement and coral rubble within the Garapan Dock area. As a result, few corals are present. The most obvious invertebrates were a coral, Pocillipora damicornis, along the dock, sea cucumbers, mainly Holothuria atra and the jellyfish, Cassiopea sp.

Environmental Setting With The Project

The preliminary project description indicates that all structures would be located within the present or former urbanized areas of Garapan (Fig. 2). Most of the project area is now covered with nearly pure stands of tangan-tangan although there are a few patches of taller vegetation, e.g., at the Sugar-King Memorial Site, that existed even before the U. S. invasion. Construction of the levee would destroy the vegetation and thus habitat for a number of bird species. This environmental degradation should be temporary and levee construction may allow bird habitat enhancement if a variety of plant species are used to revegetate the levee. Increased plant species and statigraphic diversity should eventually be reflected in increased faunal diversity.

The channel would also have a minimally adverse effect on the terrestrial biotic environment. If the channel bottom is below sea level, it would retain water and sediments and perhaps provide some additional feeding habitat for wading birds. The concrete sides and shallow areas within the channel may provide habitat for brackish water flora and fauna including mudskippers, juvenile mullet and flagfish (Kulia sp.).

The tentative seaward opening of the channel will very likely be a site for silt deposition. This problem will probably accelerate as land is cleared and the Garapan area is more intensively urbanized. Prolonged siltation at the mouth may be detrimental to the present nearshore biotic community although little is known about the ability of shallow water sea grasses and algae to maintain themselves while being subjected to various levels of siltation. There are tentative plans to construct a small boat harbor at Garapan Dock. If the harbor is constructed, it would probably trap silt released from the channel. Patterns on aerial photographs of the Garapan Dock area suggest that strong currents flow north. Filling of former trans-reef channels along Garapan indicates that substantial sediment transport takes place. Frequent input of fine sediments into the proposed harbor may result in constant high turbidity and consequently prevent the recovery of the sea grass community following harbor construction.

The small swampy area just north of Garapan may experience either beneficial or adverse effects if runoff water is directed into it. Siltation would eventually raise the floor of the marsh enough to allow the invasion of mesic vegetation and depletion of Phragmites and other wetland plants. However, if silt is removed from the runoff prior to its entry into the marsh, the increased water input may allow expansion of marsh vegetation. This swamp is inhabited by the endangered nightingale reed warbler and the proposed endangered Marianas gallinule. Both of these species are dependent upon marsh habitat.

Discussion/Recommendations

Although the Garapan area was devastated during World War II and highly altered by post-invasion construction, much of the area has substantial native faunal populations. With the possible exception of the Marianas megapod, which may have been present before World War II, there has probably been an increase in bird populations within the project area. This resulted from the succession of previously cultivated fields into a shrub community and in the revegetation of much of the urban Garapan area after post-World War buildings were abandoned and deteriorated.

The upper watershed has a high proportion of indigenous and endemic birds while the urbanized Garapan Plain hosts a greater exotic element. There are four birds that are proposed for endangered status present in the upper drainage, an area that is also suitable Marianas megapod habitat. This latter species, considered extinct on Saipan in 1949 (Ref. 8), is becoming re-established on Saipan. Service biologists heard four individuals at Marpi Point behind the "last Japanese command post" monument on May 5, 1979.

Much of the previously cleared land has been revegetated with tangan-tangan. The nearly monotypic stands of this shrub are so dense that expansion of more diverse surrounding forest communities is probably inhibited. Low strategraphic complexity within the tangan-tangan communities probably relates to the low variety of birds and probably other fauna in this habitat type.

In order to minimize adverse effects to fish and wildlife resources within the Garapan region, we believe the following recommendations should be followed during development and construction of this project.

1. Contruction should be limited to the former urbanized area of Garapan.

2. Vegetation in the watershed above Garapan should not be disturbed.

3. The location of the channel outlet should not be up current from the proposed small boat harbor at Garapan.

4. The heavy use of Micro Beach by tourists that observe fish and wildlife habitat while snorkeling indicates that that area should not be used as an outlet location.

5. The former dredged channel just south of the Intercontinental Hotel appears to be the site that would be least damaging to the marine environment. Aerial photographic evidence suggests that longshore currents are moving in a more seaward direction at this point than at other points within the project boundaries. We recommend that the outlet channel be located at this site. Onsite current analysis should be conducted in order to confirm our photographic analysis. A prediction of sediment transport and deposition should be included as part of future project plans.

6. If the swamp north of Garapan is considered as an outlet, the amount of siltation or water retention should be predicted as part of the project plans.

7. All proposed alternatives should include a means of trapping silt, such as silt basins, sod waterways, etc. before it enters the lagoon.

8. The channel should be lined with sod instead of cement.

9. Because of the high number of endangered and proposed endangered animals present within this watershed, particular care should be taken to avoid destruction of vegetation during construction.

10. The Office of Endangered Species, U.S. Fish and Wildlife Service, should be contacted in regard to the proposed and possible existing endangered species within the project area.

We appreciate this opportunity to comment.

Sincerely yours,

Maurice H. Taylor

Maurice H. Taylor
Field Supervisor
Division of Ecological Services

cc: PIA
NMFS
CNMI - DNR
EPA, San Francisco
ES, Wash D.C.
Region I Area Offices

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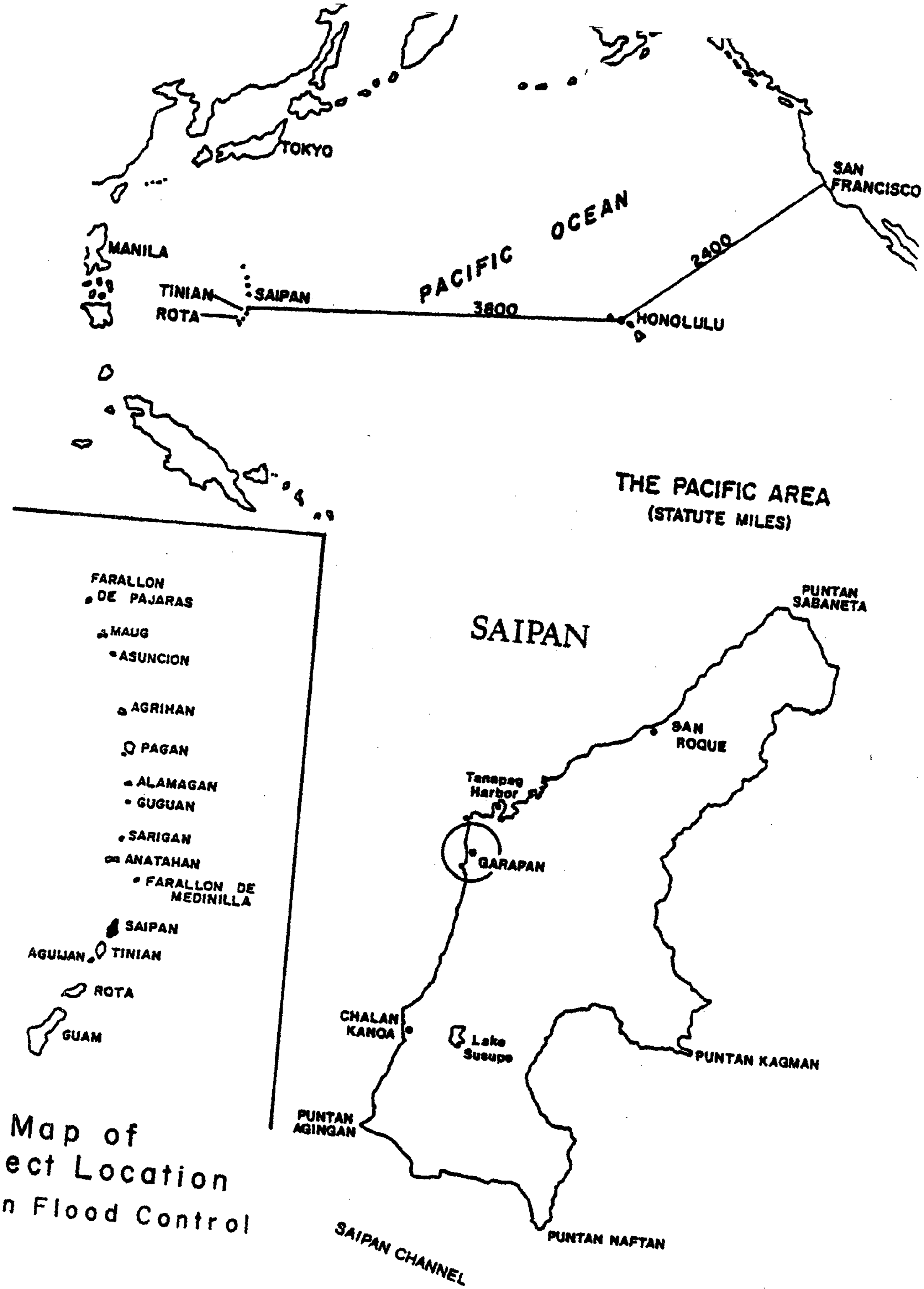
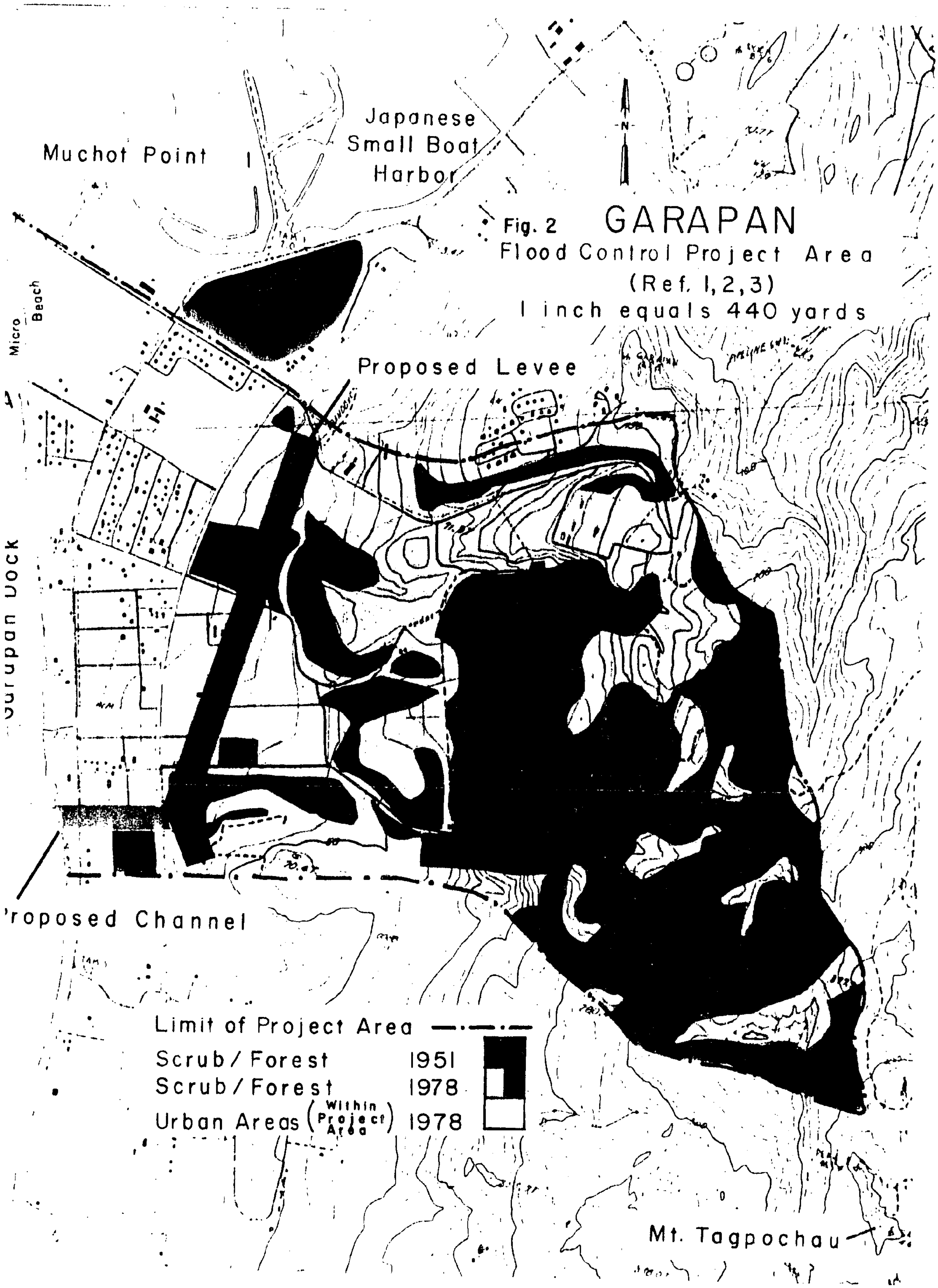


Fig. 1 Map of Project Location

Garapan Flood Control



Japanese
Small Boat
Harbor
Muchot Point
Fig. 2 GARAPAN
Flood Control Project Area
(Ref. 1,2,3)
1 inch equals 440 yards
Micro Beach
Proposed Levee
Garapan Dock
Proposed Channel
Limit of Project Area
Scrub/Forest 1951
Scrub/Forest 1978
Urban Areas (Within Project Area) 1978
Mt. Tagpochau

TABLE 1. Dominant plants observed in the Garapan Drainage.

TREES

COMMON NAME	SCIENTIFIC NAME
Kapok Tree	*Ceiba pentandra*
African Tulip Tree	*Spathodea campanulata*
Ironwood	*Casuarina equisetifolia*
Tangan Tangan	*Leucaena leucocophala*
Papaya	*Carica papaya*
Breadfruit	*Artocarpus incisus* or *mariannensis*
Mango	*Mangifera indica*
Bamboo	*Bambusa vulgaris*
Banana	*Musa* sp.
Coconut	*Cocos nucifera*
Betel Nut	*Areca cathecu*
Acacia	*Acacia confusa*
Flame Tree	*Delonix regia*
Screw Pine	*Pandanas tectorius*
Nilo	*Thespesia populnea*
Hau	*Hibiscus tiliaceus*
	Pluchea indica

UNDERGROWTH

COMMON NAME	SCIENTIFIC NAME
Rat-tail Dropseed	*Sporobolus elongatus*
Lovegrass	*Eragrostis tenella*
Guinea Grass	*Panicum maximum*
Sword Grass	*Miscanthus floridulus*
Crowfoot Grass	*Dactyloctenium aegyptium*
Lagundi	*Vitex trifolia*
Sword Plant	*Sansevieria trifasciata*
Passion Fruit	*Passiflora foetida var. hispida*
Sedge	*Cyperus odoratus*
Candlebrush	*Cassia alata*
Coffee-Senna	*C. occidentalis*
Upland Taro	*Alocasia macrorrhiza*
False Verbena	*Stachytarpheta indica*
Beach Morning Glory	*Ipomoea pes-caprae*
Nigas	*Pemphis acidula*

TABLE 2. Vertebrates observed or believed to be present in Garapan watershed and nearshore area. See Table 3 for birds.

COMMON NAME	SCIENTIFIC NAME
MAMMALS	
Cow	*Bos* sp.
Pig	*Sus scrofa*
Dog	*Canis familiaris*
Cat	*Felis domesticus*
Marianas Fruit Bat	*Pteropus mariannus*
Norway Rat	*Rattus norvegicus*
Roof Rat	*R. rattus*
Polynesian Rat	*R. exulanis*
Mouse	*Mus musculus*
REPTILES	
Bluetail Skink	*Emoia cyanura*
Brown Skink	*Emoia* sp.
Green Skink	*Lamprolepis smaragdina*
Green Anole	*Anolis* sp.
Indian Monitor	*Varanus indicus*
Geckos	Gekkonidae
Green Sea Turtle	*Chelonia mydas*
Pacific Hawksbill Turtle	*Eretmochelys imbricata*
AMPHIBIANS	
Marine Toad	*Bufo marinus*
FISHES*	
Spotted Moray	*Gymnothorax nebulosa*
Squirrelfish	*Flammeo sammara*
Squirrelfish	*Myripristis murdjan*
Cardinalfish	*Apogon novemfasciatus*
Cardinalfish	*A. nubilis*
Cardinalfish	*Paramia quinquelineata*
Snapper	*Lutjanus fulvus*
Blueline Snapper	*L. kasmira*
Snapper	*Lutjanus* sp.

TABLE 2. (Continued)

COMMON NAME	SCIENTIFIC NAME
FISHES*	
Rudderfish	*Gerres argyreus*
Scorpionfish	*Scorpaenodes guamensis*
Threadfin Butterflyfish	*Chaetodon auriga*
Saddleback Butterflyfish	*C. ephippium*
Threespot Damselfish	*Dascyllus trimaculatus*
Damselfish	*Eupomacentrus albifasciatus*
Damselfish	*Gyphidodontops leucopomus*
Damselfish	*Plectroglyphidodon leucozona*
Wrasse	*Cheilinus trilobatus*
Wrasse	*Cheilinus* sp.
Wrasse	*Cheilio inermis*
Wrasse	*Halichoeres trimaculatus*
Wrasse	*Stethojulis strigiventer*
Wrasse	*Stethojulis* sp.
Parrotfish	*Scarus ghobban*
Parrotfish	*S. sordidus*
Parrotfish	*Scarus* sp.
Surgeonfish	*Acanthurus xanthopterus*
Rabbitfish	*Signaus argenteus*
Rabbitfish	*S. spinus*
Sabretooth Blennie	*Plegiostremus tapeinosoma*
Blennie	*Salarias fasciatus*
Goby	*Amblygobius albimaculatus*

*Species listed for nearshore habitat at Garapan by Amesbury *et al* (1979).

TABLE 3. Birds observed in the Garapan Drainage, May 3, 1979.

SPECIES		Upper Northern Drainage 0900 - 1100 hr		Urban-Beach Area 1200 - 1300 hr	
COMMON NAME	SCIENTIFIC NAME	No. Observed	%	No. Observed	%
Cardinal Honeyeater*	*Myzomela cardinalis*	50	39.7	17	15.9
Golden Honeyeater	*Cleptornis marchei*	10	7.9	1	.9
Eurasian Tree Sparrow	*Passer montanus*	30	23.8	51	47.7
Marianas Crow*	*Corvus kubaryi*	1	.7	2	1.9
White Tern	*Gygis alba*	12	9.5		
White Throated Dove*	*Gallicolumba xanthonura*	1	.7		
Marianas Fruit-Dove*	*Ptilinopus roseicapilla*	2	1.6	17	15.9
Philippine Turtle-Dove	*Streptopelia bitorquata*	8	6.3		
Collared Kingfisher	*Halcyon chloris*	4	3.2	13	12.1
Bridled White-eye*	*Zosterops conspicillata*	8	6.3	1	.9
Rufous-fronted Fantail	*Rhipidura rufifrons*			2	1.9
Lesser Golden Plover	*Pluvialis dominica*			2	1.9
Whimbrel	*Numerius phaeopus*			1	.9
Wandering Tattler	*Heteroscelus incanum*				
	Total Individuals	126	100%	107	100%
	Total Species = S	10		10	

		Upper Northern Drainage	Urban-Beach Area
Shannon-Wiener Index of Diversity = $-\ p_i \log_{10} p_i = H$	=	.7499	.6811
$H_{max} = \log_{10} S$	=	1.00	1.00
Equitability = $E = H/H_{max}$	=	.7499	.6811

*proposed endangered species (Ref. 5)

TABLE 4. Marine Plants in sandy inshore habitat along Garapan. Reported by FitzGerald and Tobias (1974).

Location: 1400 yards north of Garapan Dock. 29.7% algal cover, 70.3% sand.

Species in decreasing order of abundance

1. *Chondria repens*
2. *Laurencia tropica*
3. *Acanthophora spicifera*
4. *Microcoleus lyngbyaceus*
5. *Neomeris vanbosseae*
6. *Gracilaria lichenoides*
7. *Calothrix confervicola*
8. *Schizothrix calciocola*

Location: Garapan Dock. No percent cover or abundance indicated.

Species observed

Green Algae:	*Enteromorpha compressa*
	Halimeda macroloba
	H. opuntia
	Dictyosphaeria versluyii
	Valonia fastigiata
Red Algae:	*Spryidia filamentosa*
	Tolpiocladia glomerulate
Seagrass:	*Enhalus acoroides*
	Halodule ininervis
	Halophila minor